Spring 2010

Didactic Architecture: A Tectonic Response

Elizabeth Kankainen

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Designing a environmental education center

Elizabeth Kankainen
Arc 505 Thesis Preparation
Undergraduate
Prof. de Riva, Prof. Korman

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Abstract

"Architecture is an art because it is interested not only in the original need of shelter but also in putting together spaces and materials in a meaningful manner. This occurs through formal and actual joints. The joint, that is the fertile detail, is the place where both the construction and construing of architecture take place." - Marco Frascari

"Nature is constantly fluctuating and changing; yet it is always on time. It partakes on the permanence of things, but it's also the impermanence, the paradoxical harmony of change and constancy." (Price, 46)

Architecture is often described as 'space making.' This assumption infers a sense of completion or wholeness and reduces architecture to the volumes it creates, therefore, ignoring the materials and the techniques it utilizes. The average person is not aware of a buildings composition. The various processes which lead to construction go unnoticed in a buildings completion. Architecture that is didactic and instructive allows the user to understand the design intent, organization and construction of a building. It is a crucial part of creating sustainable architecture, because if architecture continues to be abstracted into spaces instead of being understood as parts which create a whole, than awareness of consumption and utilization of materials and energy is forgotten.

Using the tectonic nature of architecture as the vehicle, architecture can educate its users of material life cycles. Through revealing particular stages of production by exposing, exaggerating and juxtaposing the connections between materials, the physical process of a buildings formation can be understood, along with architecture's inherent connection to nature.

An environmental education center will allow for tourists visiting rural Maine to be educated of local logging practices and wood's role in a sustainable world. The facility will aid the learning process as well as exploit the building's relationship with nature.

Through the development of the thesis, consideration will be given to the fact that the different stages in the construction process should be taught through different approaches of design and that not all stages hold the same importance.

Glossary of Terms

Sustainable Architecture- Seeks to minimize the negative environmental impacts of a building by enhancing efficiency in the use of materials, energy, and development of space. Sustainable design plans for the future.

Didactic Architecture- Architecture which is morally Instructive; inclined to teach, exposes and makes clear its objective

Tectonic- The act of joining. "A certain expressivity arising from the statical resistance of constructional form in such a way that the resultant expression could not be accounted for in terms of structure and construction alone." (Eduard Sekler)

Ecological Footprint- Tries to measure its consumption of natural resources and the amount of biologically productive land and sea needed to regenerate those resources and to absorb and render harmless the waste that is produced.

Forest Stewardship Council- An international certification organization that had established voluntary environmental forest management standards. FSC accredits independent third-party organizations that monitor and certify the compliance of forestry operations with FSC standards. FSC-labeled wood products give consumers assurance that the wood comes from trees frown and harvested in an environmentally responsible manner.

Theoretical Framework

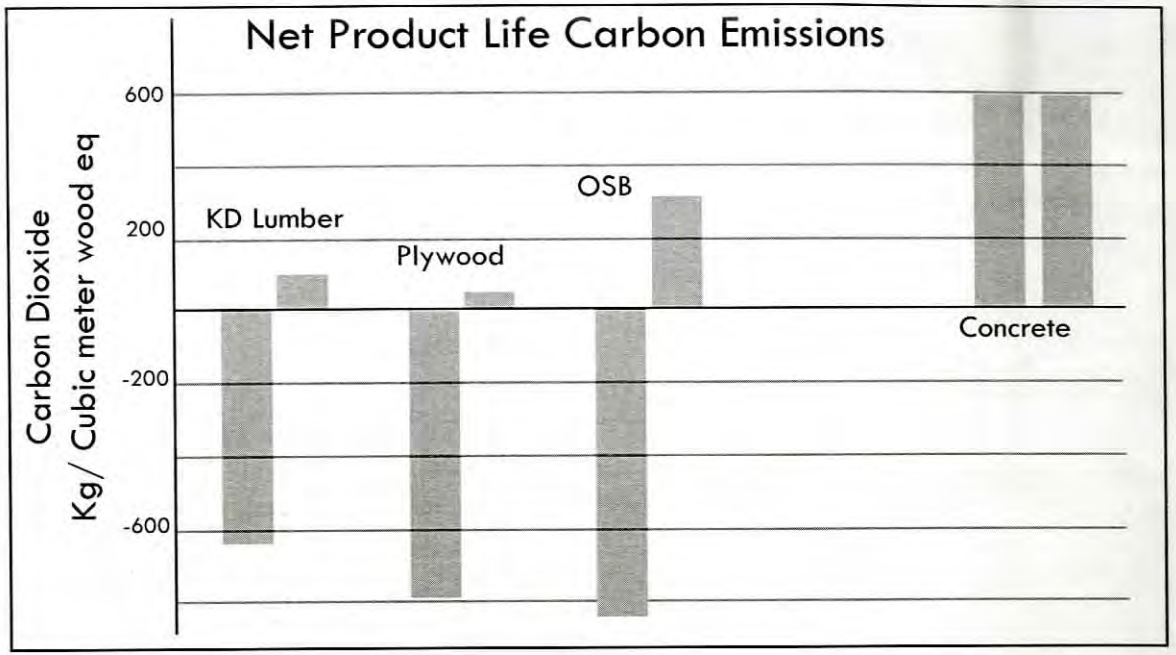
The building industry is the largest consumer of raw materials in the world today after food production. - Bjorn Berge

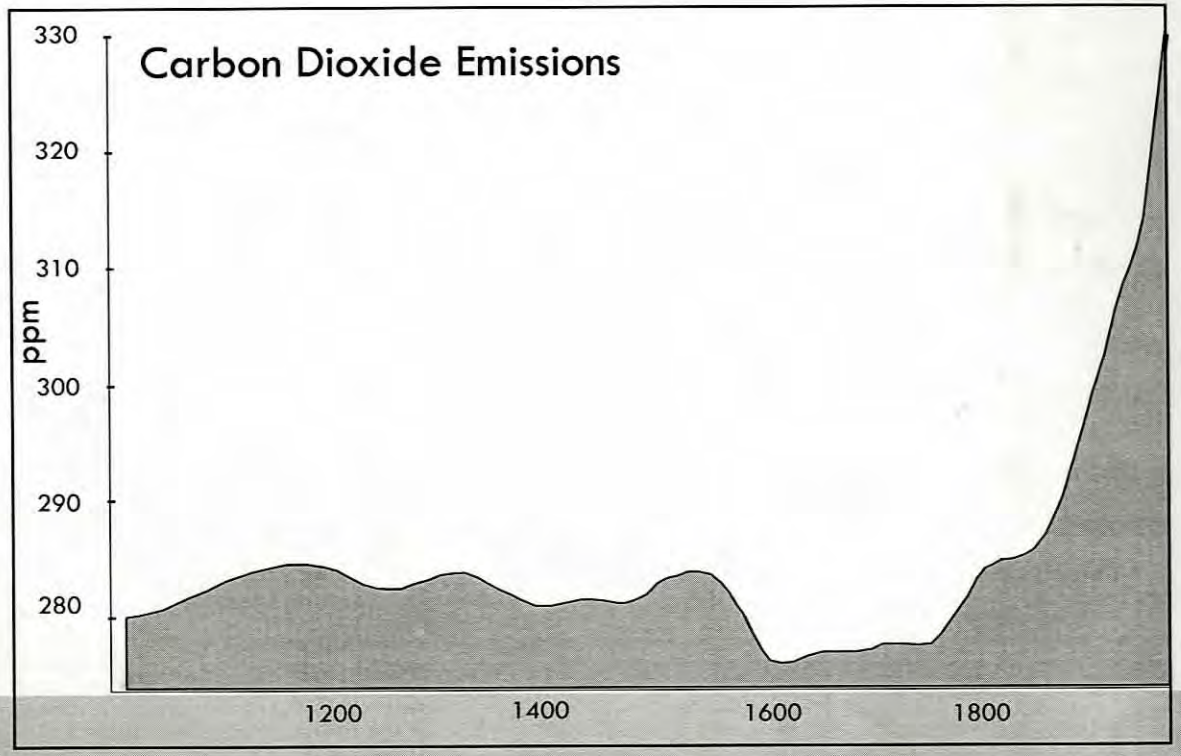
The Global Effect: climate change

Since the industrial revolution the increase of green house gas emissions, most notably Carbon Dioxide has increased at an alarming rate. The anthropogenic effect on the earth's atmosphere is causing global warming and the depletion of the ozone layer. "40% of the world's materials and energy is used by buildings" ("Worldwatch Paper #124.") that means as architects we effectively contribute to 40% of global warming and climate change. We have the ability to reduce our footprint on this planet and it begins with implementing renewable materials and rethinking the building process.

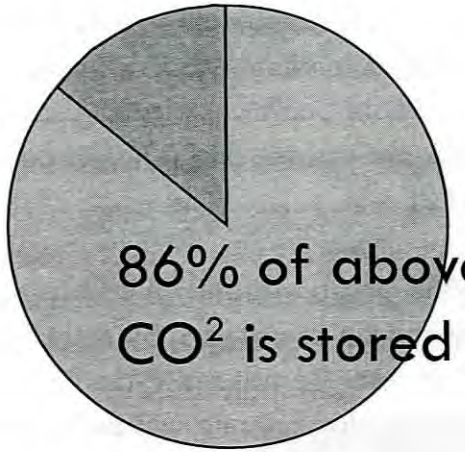
Wood: a renewable material

One way to reverse CO2 emissions is to use one of the most renewable materials: wood. Not only can a harvested forest sustain itself through good management, but it also can lead to more carbon stored in lumber and other wood prod-



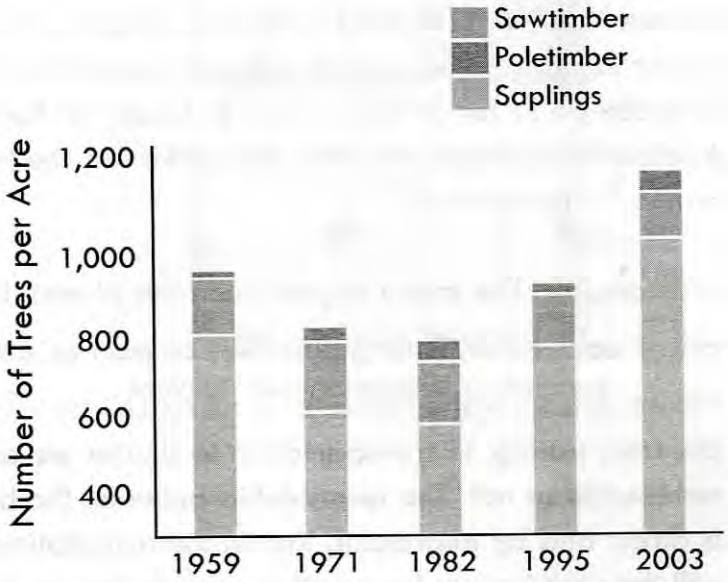


ucts rather than it being released through decay. Wooden structures may be the most eco friendly of building materials, but they also use a lot of carbon producing agents in the process: cranes to lift large trusses into place, power tools that use constant electricity and for a small home at least 250 lbs of nails. An example of building in wood without these amenities is the art of Japanese joinery. Their refined techniques of creating connections in wood that withstand years of both lateral and shear forces pulling them apart without a single nail is an inspiration to how buildings can be put together like a puzzle, that when interlocking has more strength than the typical building techniques today.

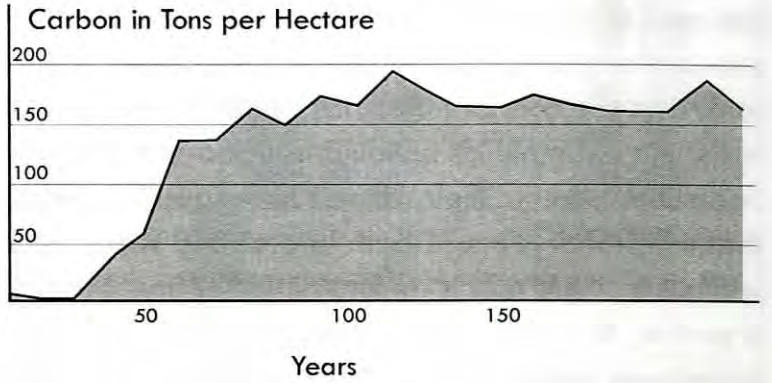


"Until the introduction of steel construction at the beginning of the industrial revolution, timber was the only material with which man could build a complete structural framework. Timber unites qualities such as lightness, strength and elasticity. Compared with its weight, it is 50 per cent stronger than steel. It is more hygienic than other similar materials – the growth of bacteria on kitchen benches of timber is much lower than that on benches of plastic or stainless steel. Timber also has good thermal conductivity. These qualities mean that, in relation to most modern European building standards, timber can be used in up to 95 per cent of the components of a small building. This includes everything from roof covering to furniture, thermal insulation and framework." (Berge, 156)

"Timber is a recyclable material, and in the form of prefabricated components it can be re-used in many different situations. The re-use of logs, in part or as a whole, has been ubiquitous in most of Norway and Sweden. Both log construction and stave construction are building techniques where the components can be easily dismantled and re-erected without any waste. The Japanese have developed a whole series of techniques for timber joints without glue, the most well known being the so-called 'timber locks'. Most structures in the twentieth century



have been based upon less flexible principles. Gluing and nailing have been the dominant methods of jointing. Modern timber-frame construction is at best firewood after demolition! Some chemicals, glues and surface treatments make timber unsuitable for use as fuel, and it has to be considered a problematic waste". (Berge, 172)

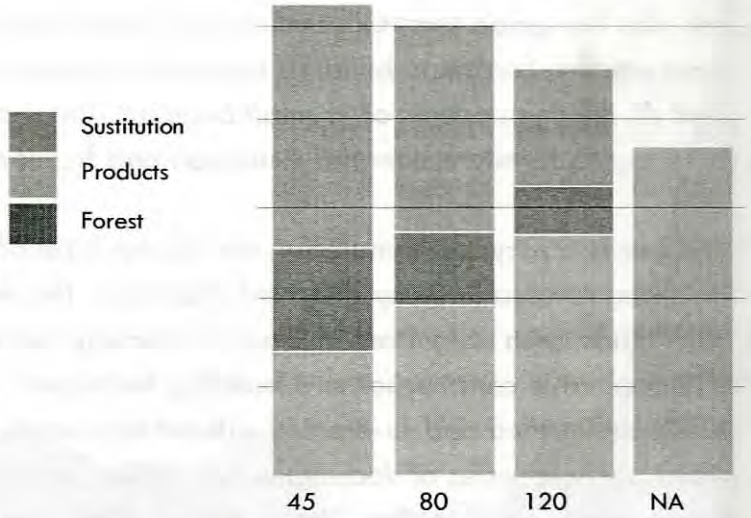


By using wood as the primary material in construction resources can be saved and energy can be conserved. By rethinking the use of wood at a rate that matches up with the natural cycle the relationship between the built environment with the ecological one will be in sync rather than in opposition

Architectures Inherent Connection to Nature

"Human life is not intended to oppose nature and endeavor to control it, but rather to draw nature into an intimate association in order to find union with it. One can go so far as to say that, in Japan, all forms of spiritual exercise are traditionally carried out within the context of the human interrelationship with nature." - Tadao Ando

Humans, just like every organism on this planet, live off the environment and off of each other, finding ourselves as part of a food chain, an interconnectedness with nature is intrinsic to who we are. Everything we do, from eating, to transportation to shelter we are taking natural resources, renewable or not. The relationship between the built environment and nature is direct and by expressing that in the articulation of the connection, not only will the architecture be one that is more honest; but it will also tell the story of its life cycle and use.



"Situated at the interface of culture and nature, building is as much about the ground as it is about built form." –Kenneth Frampton

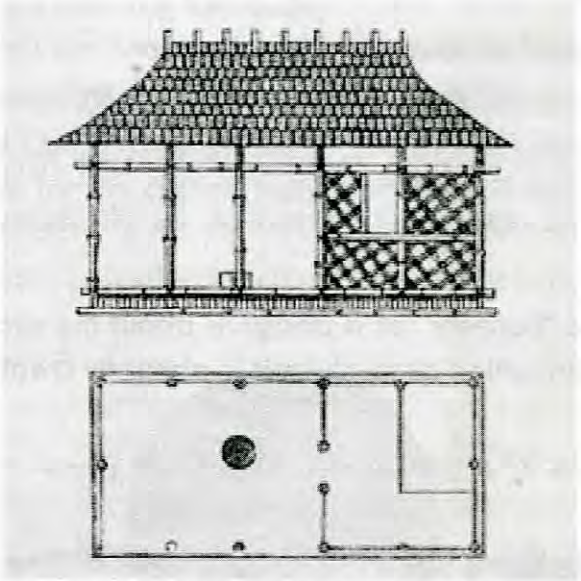
Semper draws the distinction between Stereotomic and Tectonic, the stereotomic signifying the heaviness of the earthwork and the tectonic being understood as the light framework and assemblage of dwelling. The boundary between these two entities, the interplay between the two is as much a joint in the architecture as the entire tectonic nature of the assemblage. This joint may be the most vital of them all. To understand the relationship between the nature of the stereotomic and the tectonic one can look at the Saynatsalo Town Hall by Alvar Aalto. The stereotomic grows into a completely enclosed brick staircase, which is understood as dark and grounded, it then releases into the tectonic light wooden framework of the meeting hall. The two serve not only different programmatic needs, but more importantly serve different tactile needs.

Tectonic Architecture

'... given the real need for production and the fundamental desire for honest self-expression, the machine can be put to all its legitimate uses as an aid to, and a preparation for, the work of the hand, and the result be quite as vital and satisfying as the best work of the hand alone.' - Gustav Stickley 'The use and abuse of machinery'

Schinkel's first Principle of Art in Architecture was that to build is to join different materials into a whole corresponding to a definite purpose. This act of joining is the tectonic nature of architecture. It is the relationship between the parts which make up the whole and should be driven by the needs of its experiential use. This theory was adapted by the Greene and Greene archi-

"Contemporary architecture, thus, has a role to play in providing people with architectural places that make them feel the presence of nature." - Tadao Ando

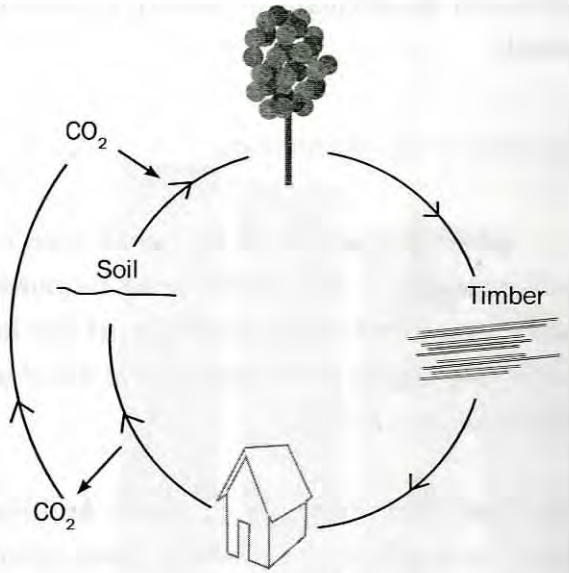


Semper's four elements of architecture

tects whose work began "to reject familiar historical styles and to assert instead that the form and decorative aspect of a building should be inspired by its intended use." However, this inherent tectonic nature of a building becomes compromised by disguising it with cladding which is purely decorative and does not convey the tectonic language beneath it. The Greene brothers do this when they add nonstructural elements to complete the aesthetic balance. Kenneth Frampton says it well when he states, "the skin that re-presents the composite character of the construction and the core of a building is simultaneously both its fundamental structure and its substance." To represent architectural honesty it should be expressive and didactic, that is to say it should overtly educate through its construction and representation of its process. The truth of tectonic architecture is that is gets put together and taken apart. The "honesty" of a design is about the process of its manipulation and adaptation as much as it is about its creation or completed state.

Life Cycle: implications of time

A building has a life cycle, a span of time in which the structure is functional and meets the needs of the inhabitant, but at a point its occupants obtain a new set of requirements and the buildings layout, size and or function becomes obsolete. At this turning point in a buildings life there are two options. One is to remain intact, allowing another program or inhabitant to occupy the space, the second is to transform;

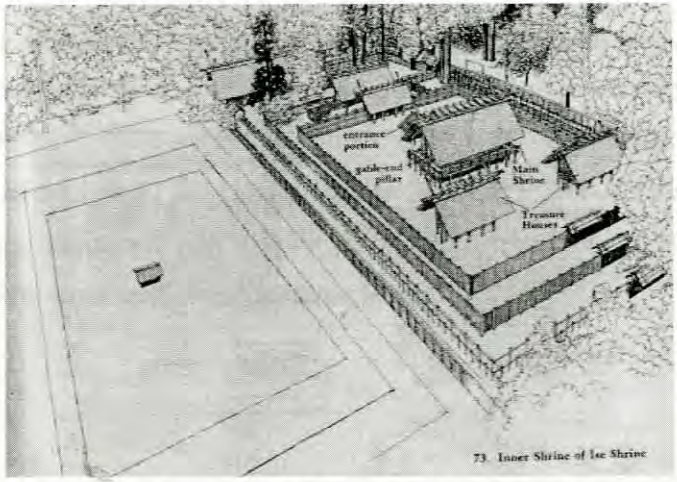


The cycle of wood use in building construction

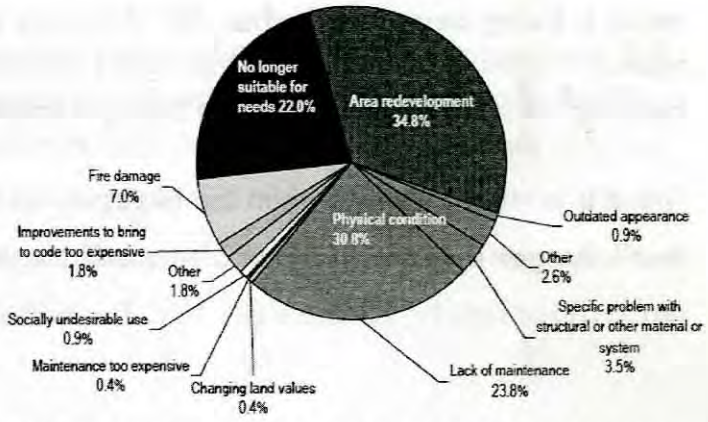
adapt, alter or ultimately demolish. Because most buildings have an expiration date from the beginning there should be a system in place from its conception to handle its deconstruction.

An example of a building technique that considers the life cycle of the material as well as its natural implications is the Eco Nest by Paula Baker-Laporte and Robert Laborte. Similar to how a bird builds a nest for shelter, never any larger than necessary, the nest is constructed and repaired by its inhabitant and when they have no more use for the space the materials decompose. This argument builds off that both humans and birds have a nesting instinct and that the process should be the same. I would argue that while this method is valid, instead of allowing the materials to decompose they should be recycled and reused while still viable. It saves more energy to reorganize existing materials than it does to accumulate and arrange new ones.

Japan is a prototype of a country which has understood building processes as a cyclical practice for thousands of years. An exaggerated example of this is the Ise Shrine that maintains "the interrelationship of every conceivable element." The shrine is perfectly reconstructed every 20 years in an adjacent site with all new materials. The reason for the cyclical nature of the building is



Watanabe, Yasutada. Shinto art: Ise and Izumo shrines. New York: Weatherhill/Heibonsha, 1974. Print.



O'Connor, Jennifer. Survey on actual service lives for North American buildings. Rep. Vancouver: Forintek Canada Corp., 2004. Print.

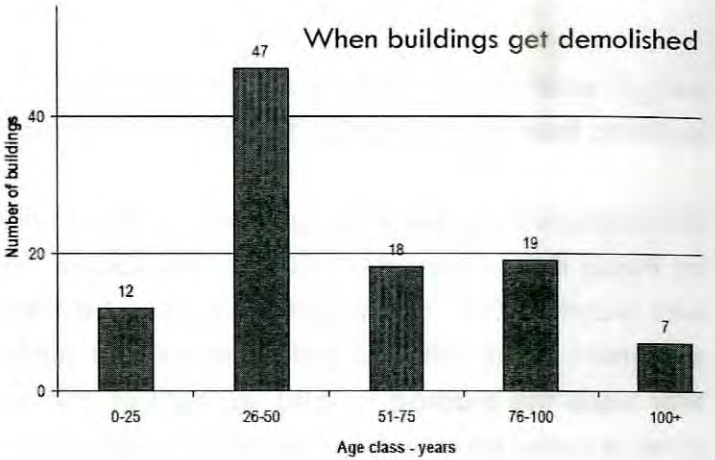
religious, but the exercise of understanding a structure as something that has a clearly defined life cycle and use is informative to architectures potential use.

Frampton wrote that duration and durability are architectures ultimate values. This can be understood as implying that architectures goal is to last a long time, or it can be seen as an observation that architectures objective is to recognize a length of use and to withstand that amount of time.

Building Life Expectancy

If materials, such as wood, steel and concrete have life spans reaching over 100 years than why is the average age of residential dwellings 32 years old (US Census, 2004)? It is because needs change. Either lack of maintenance, undesirable appearance, change in codes, redevelopment of an area or a whole slew of other excuses why a building that was meant to last 100 years is being demolished after 50. A survey done by Jennifer O'Connor, a research scientist, showed that the most common lifespan of non residential building was 26-50 years before being demolished.

There is a miscalculation when the life span of the building materials is one that is longer than the lifespan of the building itself. This discrepancy is an opportunity to design for. The building should only be designed to



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last as long as it will be functional and it should than be intended to be dismantles and reassembled at a more useful location or in a more desirable layout to minimize the amount waste that the building construction industry produces. The EPA estimates that 136 million tons of building-related construction and demolition debris is generated by U.S. every year.

Bjørn Berge writes that there are four factors that govern the lifespan of a material, they are:

- *the material itself, its physical structure and chemical composition*
- *construction and its execution; where and how the material is fitted into the building*
- *the local environment; the climatic and other chemical or physical conditions*
- *maintenance and management*

By addressing these factors, by choosing wood, a renewable material, by designing for disassembly and by maintaining the building a material can last longer and produce less waste.

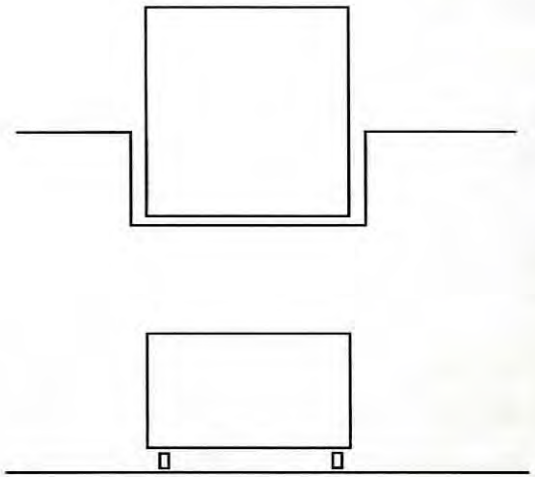
Conclusion

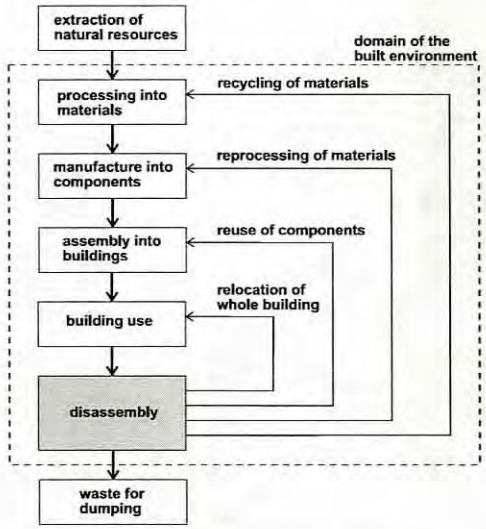
The tectonic process of creating architecture is one that consumes an excessive amount of material and energy. The source of this material is one that can regenerate at a particular speed or cycle and if designers are not conscience of this time scale, it will remain difficult for a building to become sustainable and successfully maintain a balance between the built environment and the natural one. Architecture should educate its user's of a buildings lifespan, both past, present and future by revealing the physical process which led to its creation. This way architecture can become a more comprehensive and sustainable practice.

Rethinking the Building Process

Permanence

In many cases buildings are thought of as permanent. Architecture can make its mark on the world and last hundreds, even thousands of years. By continuing to build in a way that considers architecture to be permanent, we are aiding an unsustainable process which creates waste and inefficiencies. To stop this trend we need to differentiate between permanent architecture and architecture which should be understood as something that is cyclical. **It can be created, transformed and deconstructed.** The problem with 'durable' architecture is that it lacks flexibility in the future. Even buildings like the Salk Institute by Louis Kahn, that is designed to adapt to new users can not be deconstructed and leave the site without a trace.





Crowther, Philip. "7. Design of Buildings and Components for Deconstruction." Deconstruction: Techniques, Economics, and Safety. Australia: Queensland University of Technology. Print.

The following are strategies to minimize consumption of global resources and ways to rethink the building process.

The Natural Steps

L.P. Hedeberg, from the 'Natural Step" movement wrote four conditions that will achieve a successful sustainable society.

1. Do not take more out of the crust of the Earth than can be replaced. *This means that we must almost totally stop all mining and use of fossil fuels. Materials that we have extracted from beneath the Earth's surface, for example metals, coal and oil, are difficult for Nature to renew, except in*

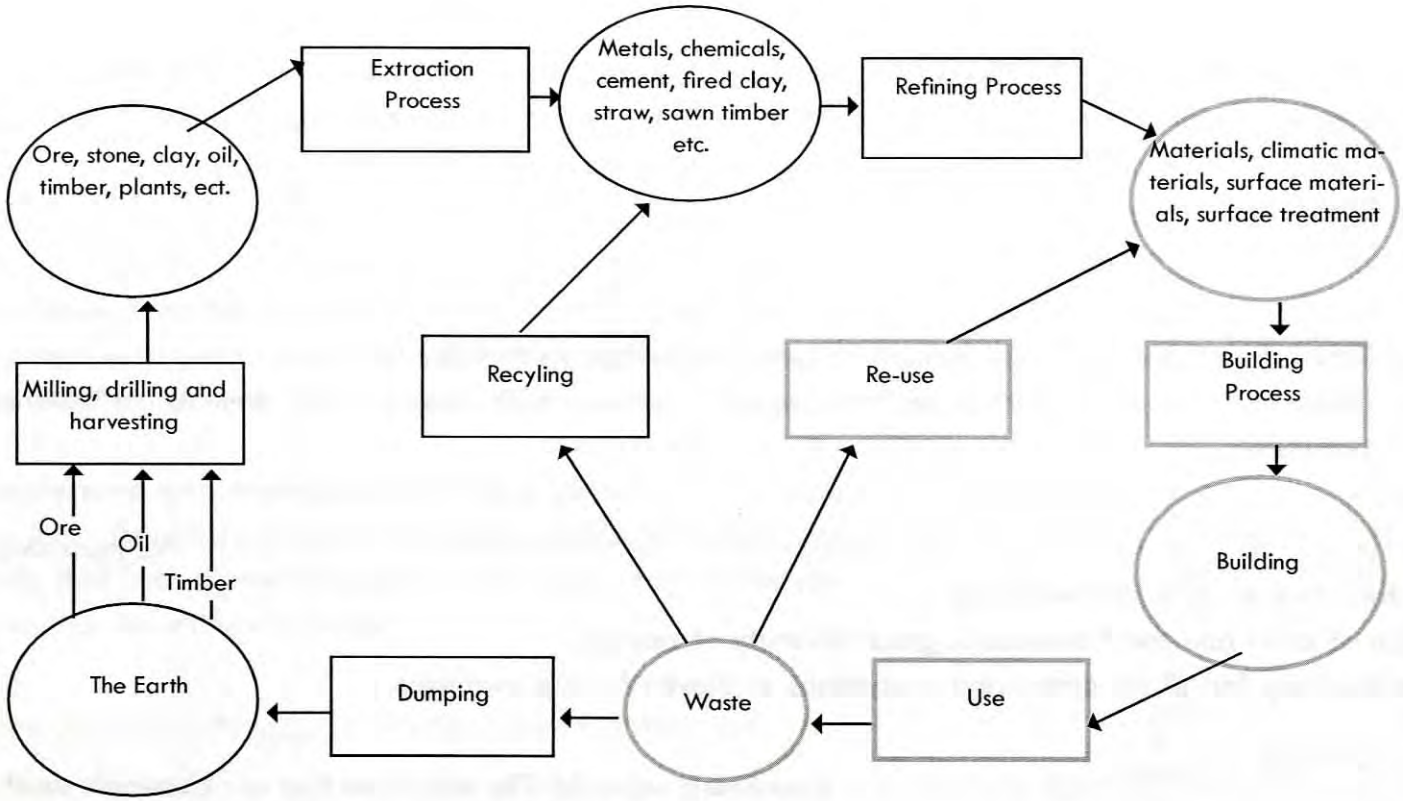
a very small part. And that takes time. On the surface the rubbish pile gets higher because we have not followed this condition. And matter does not disappear – even if we reduce it to very fine particles, by burning for example, it is only transformed into molecular waste. Every single atom of a completely rusted car continues to exist, and has to find a new home somewhere else. Everything just spreads, nothing disappears.

2. Do not use man-made materials which take a long time to decompose. *Materials that Nature can break down and change into nutrients belong to the natural lifecycle. Man-made materials, which have never been a part of Nature, are very difficult for Nature to break down. Certain synthetic materials such as PCB, dioxines, DDT, freones and chloroparaffins will never be broken down by Nature.*

3. Maintain the conditions for Nature to keep its production and its diversity. *We must stop impoverishing Nature through forest clearing, intensive fishing and the expansion of cities and road systems. A great diversity of animals and plants are a necessity for all life cycles and ecosystems, and even for our own lives.*

4. Use resources efficiently and correctly – *stop being wasteful. The resources that are available must be divided efficiently and fairly.*

These four guidelines for a sustainable society are just as effective on the micro scale of one building. By being conscious of the source and production of materials, by minimizing waste and by remaining mindful of the connection with nature, architecture can be sustainable.



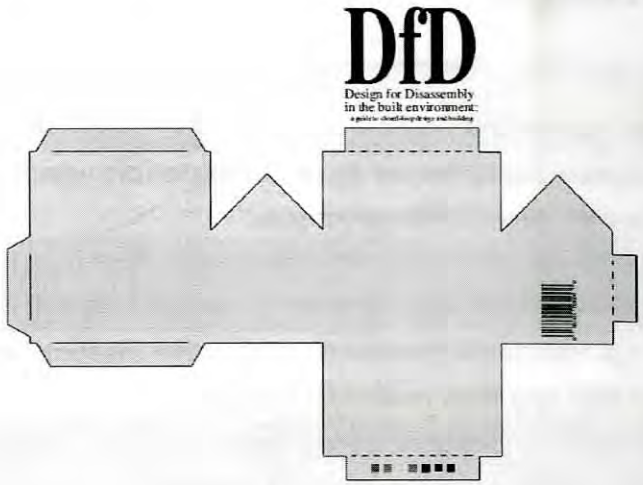
Closing the Loop in the Material Lifecyle
(Bjorn Berg, "The Ecology of Building Materials")

Closing the Loop

Bjørn Berge published this diagram in his book "Ecology of Building Materials." He is rethinking the consumption process and representing how one could begin to close the loop in the material lifecycle. He states, "Another important aspect to address is to reduce the loss of resources during production, the construction process and throughout the life of the completed building. The re-use of materials following demolition should also be taken into account. Recycling processes should be developed so that materials can be taken care of at their original level of quality, rather than downcycled."

DfD strategies	Ways that they could be exposed or represented in an educational way:
• *Use high-quality reused materials that encourage the markets for the reclamation of materials.*	*-Allow one to understand where the material came from by leaving particular markings*
• *Minimize the different types of materials which reduces the complexity and number of separation processes.*	
• *Avoid toxic and hazardous materials that increase potential human and environmental health impacts, and potential future handling.*	
• *Avoid composite materials, and make inseparable products from the same material that are then easier to recycle.*	
• *Minimize the number of different types of components to increase the quantities of similar recoverable components.*	*-Articulate each component to make clear the use of repetition as well as where variation is needed*
• *Separate the structure from the cladding to allow for increased adaptability and separation of non-structural deconstruction from structural deconstruction.*	*-Make the layers read separately from each other*
• *Provide adequate tolerances to allow for disassembly in order to minimize the need for destructive methods that will impact adjacent components.*	*-Compartmentalize and make a structural grid that reads as adaptive and subtractive*
• *Minimize numbers of fasteners and connectors to increase speed of disassembly.*	*-Expose all connections as critical points in the design*
• *Design joints and connectors to withstand repeated assembly and disassembly to allow for adaptation and for the connectors to be reused.*	
• *Allow for parallel disassembly to decrease the time on-site in the disassembly process.*	*-Design units which can operate separately*
• *Use a standard structural grid to allow for standard sizes of recoverable materials.*	
• *Use lightweight materials and components that are more readily handled by human labor or smaller equipment.*	*-Keep the building within "reach" of a human being*
• *Identify point of disassembly permanently to reduce the time in planning the disassembly process.*	*-DESIGN the disassembly process*
• *Consolidate mechanical, electrical and plumbing (MEP) systems into core units to minimize runs and hence unnecessary entanglement. (Ciarimboli, 7-8)*	

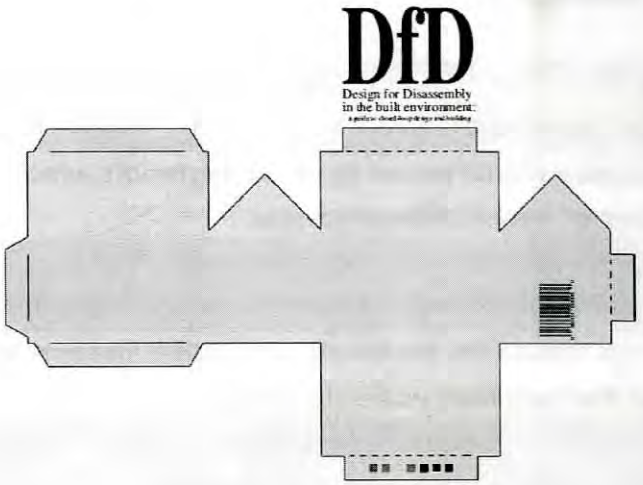
Design for Disassembly (DfD)



"DfD is the design of buildings to facilitate future change and the eventual dismantlement (in part or whole) for recovery of systems, components and materials. This design process includes developing the assemblies, components, materials, construction techniques, and information and management systems to accomplish this goal. The recovery of materials is intended to maximize economic value and minimize environmental impacts through subsequent reuse, repair, remanufacture and recycling. Of last resort are energy recovery from materials and safe biodegradation. DFD enables flexibility, convertibility, addition, and subtraction of whole-buildings." (Ciarimboli, 3-4)

The US EPA has estimated that 92% of all construction related waste produced annually in the US is the result of renovations and demolitions, *with only 8% produced from new construction, and that this waste is upwards of 30% of all waste produced in the US (Franklin Associates, 1998). Nelson has estimated that the total built space in this country will need to grow from 296 billion square feet in 2000, to 427 billion square feet in 2030. Of this growth, 82 billion square feet of building will be from replacement of existing building space and 131 billion will be from new construction totaling 213 billion square feet of new built space. This means that 27% of existing buildings in the year 2000 will be replaced from 2000 to 2030 and that over 50% of buildings in the year 2030 will have been built since 2000 (Nelson, 2004). This huge mass of buildings that are to be replaced and newly constructed can either be large sources of waste in the next generation after 2030, or they can incorporate DfD to recover their materials from future repairs, renovations, and removals. (Ciarimboli, 2)*

Design for Disassembly (DfD)



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Stages of Construction

Stage 1- Tree is cut

CO2 ← **Stage 2-** Logs are taken by truck to the sawmill

Stage 3- Logs are scaled and sorted by species, size and end use

Stage 4- Debarking

Paper ← Wood Chips ← **Stage 5-** The primary saw breaks the log into unfinished logs and unfinished planks

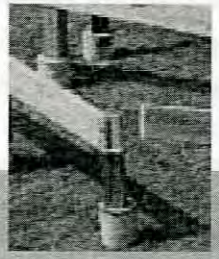
Stage 6- Edging will trim off all irregular edges leaving four-sided lumber.

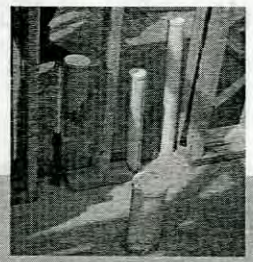
Stage 7- Drying removes naturally occurring moisture from the lumber

Stage 8- Planing smoothes the surface

CO2 ← **Stage 9-** Transport to site

Stage 1 – Footings → **Stage 2-** Framing → **Stage 3-** Plumbing, Mechanical, Electrical → **Stage 4-** Insulation → **Stage 5 -** Exterior and Interior Finish





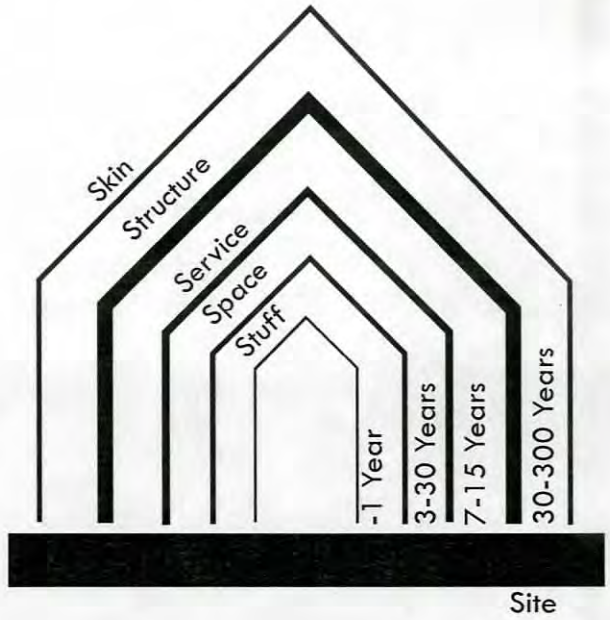
Estimated Life Span in Years

Concrete/block foundation	100+
Exposed concrete slabs	25
Siding (Lifespan depends on type)	10 -100
Drywall	30 - 70
Roofing	15 - 30
Gutters and Downspouts	30
Insulation	100+
Windows	20 - 50
Exterior Doors	25 - 50
Garage Doors	20 - 50
Exterior paints/stains	7 - 10
Wood floors	100+
Carpeting	11
Sinks	5- 20
Toilets	50
Faucets	13 - 20
Water heater	14
Central air conditioning/ heat pump (outside unit)	15
Furnace/heat pump (indoor unit)	18
Refrigerator	17
Dishwasher	10
Clothes Dryer	14
Clothes Washer	13
Smoke Detector	12
Wood Framing	100+

Majority of appliances < 20 year life span

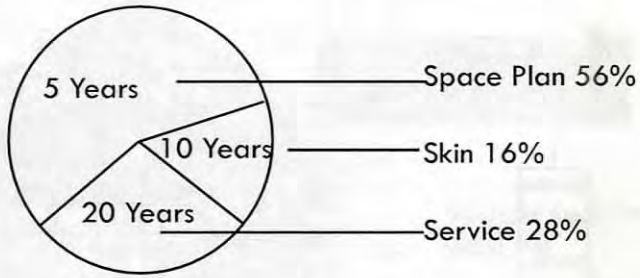
Building in Layers

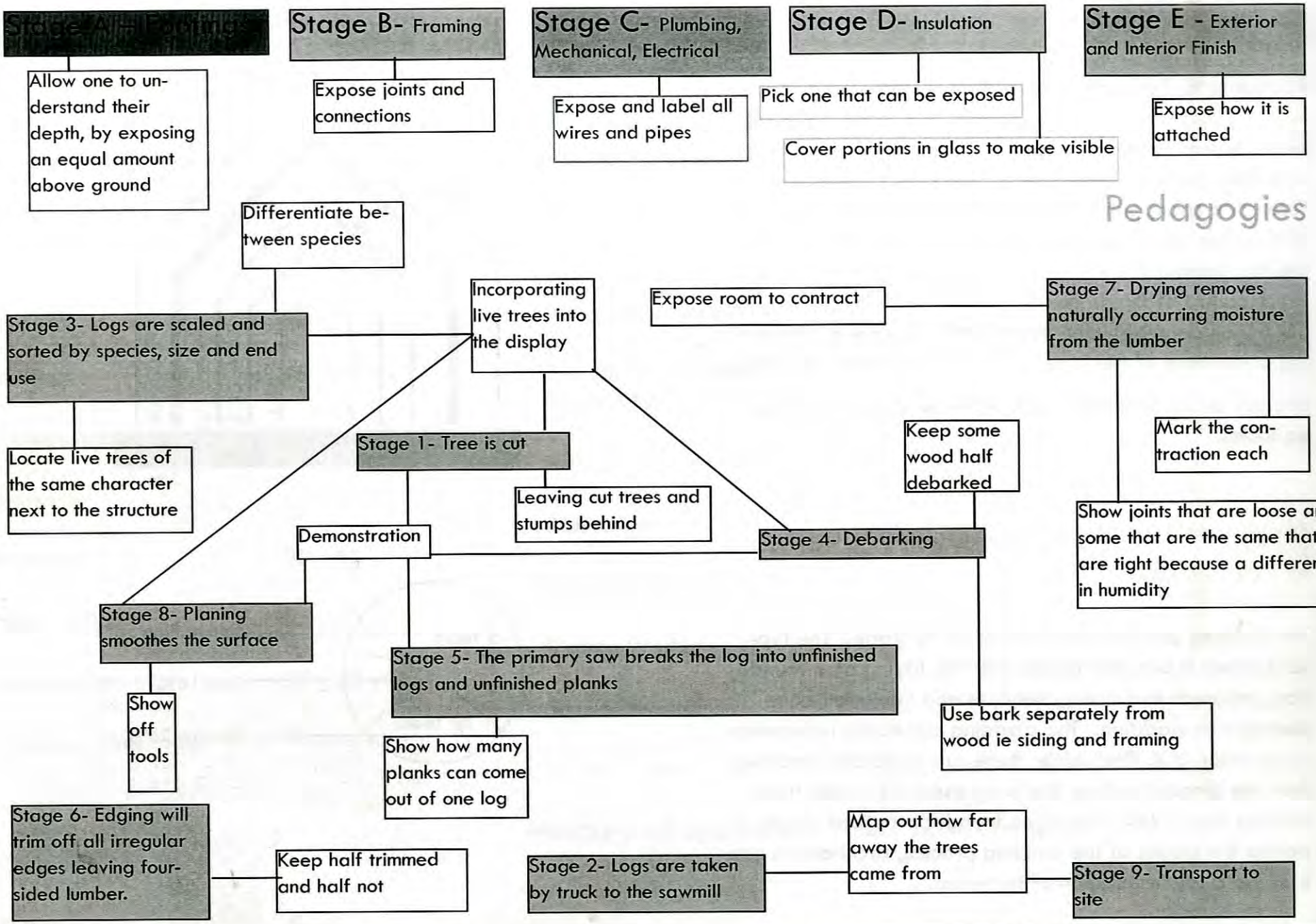
According to Stewart Brand, author of "How Buildings Learn: What Happens After They're Built ", buildings consist of layers, each has a speed of change which is separate from the rest. There are six layers, each with a different life span, going from the inside to the out they are: stuff, space plan, services, skin, structure and the site. The site has eternal life whereas elements like the space plan, which consist of things like the interior walls, might have a life expectancy between three to thirty years. By remaining contentious of the layers of a building while designing, one can avoid premature demolition to due partial inadequacies.



Stages of Building Construction: opportunity for expression

The building process incorporates many stages. The typical process is one that begins with the laying of a foundation, proceeds to framing, services and insulation, completing with cladding. The cladding can easily hide every stage prior to it. That aside, there are numerous processes that are ignored such as the progression of a tree transforming into a 2x4 or how the foundation is laid. By exposing the stages of the building process, architecture can truly be a representation of its means.

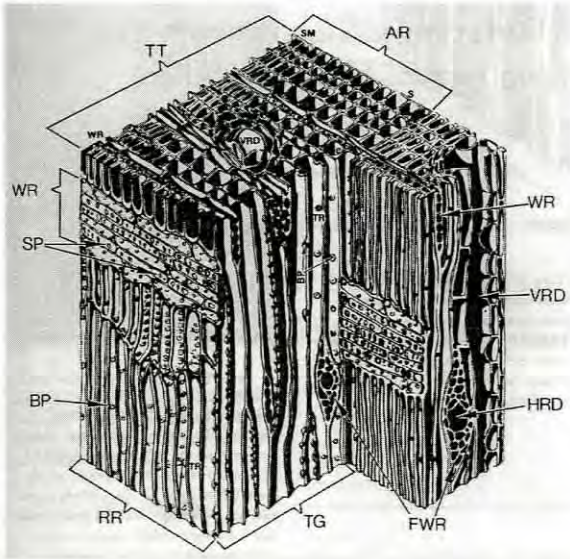



Stage A- Footing
Allow one to understand their depth, by exposing an equal amount above ground
Stage B- Framing
Expose joints and connections
Stage C- Plumbing, Mechanical, Electrical
Expose and label all wires and pipes
Stage D- Insulation
Pick one that can be exposed
Cover portions in glass to make visible
Stage E - Exterior and Interior Finish
Expose how it is attached
Pedagogies
Differentiate between species
Stage 3- Logs are scaled and sorted by species, size and end use
Locate live trees of the same character next to the structure
Incorporating live trees into the display
Stage 1- Tree is cut
Leaving cut trees and stumps behind
Demonstration
Stage 8- Planing smoothes the surface
Show off tools
Stage 5- The primary saw breaks the log into unfinished logs and unfinished planks
Show how many planks can come out of one log
Stage 6- Edging will trim off all irregular edges leaving four-sided lumber.
Keep half trimmed and half not
Stage 2- Logs are taken by truck to the sawmill
Map out how far away the trees came from
Stage 9- Transport to site
Expose room to contract
Stage 7- Drying removes naturally occurring moisture from the lumber
Mark the contraction each
Show joints that are loose and some that are the same that are tight because a difference in humidity
Keep some wood half debarked
Stage 4- Debarking
Use bark separately from wood ie siding and framing

The stages of a trees transformation start with tree growth. The requirements for tree growth include sun light, water and soil and nutrients. Vertical cells located within the tree structure hold the nutrients that it absorbs. Sawing, which is the process of cutting a tree down and turning it into lumber, is the most elaborate process. It begins with the felling of the tree. Using a harvester to reach into the forest, cut the tree at its base and leave the roots behind, this large piece of equipment does surprisingly little damage. After the tree is felled by the harvester a logging truck transports the trees to a sawmill. "Sawmills range in size from tiny family operations to giant, semi automated factories, but the process of lumber production is much the same regardless of scale. Each log is stripped of its bark, then passed repeatedly through as large headsaw, which may be either a circular saw or a bandsaw, to reuse it to untrimmed slabs of lumber." (Allen, 78)

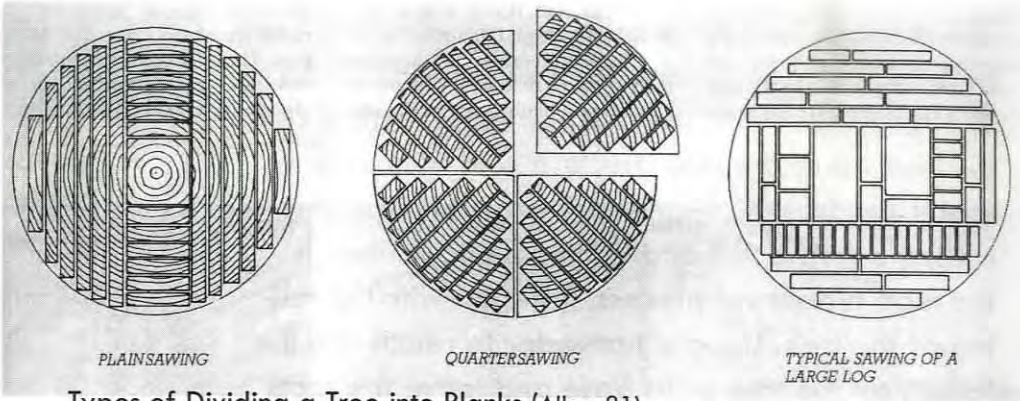
To achieve the maximum marketable lumber out of a piece of wood, one much pay attention to its size, species and density. There are two ways to cut a log: plainsawed and quartersawn. Plainsawing is used primarily for framing, while quartersawing, for visual reason, is used for flooring, trim and furniture. (Allen, 79)

Harvester



Vertical Cells With a Tree (Allen, 75)

"Nor do I ever come to a lumber yard with the city-like graduated masses of fresh shingles, boards and timbers, without taking a deep breath of its fragrance, seeing the forest laid low in it by processes that cut and shaped it to the architect's scale of feet and inches..."
Frank Lloyd Wright



Types of Dividing a Tree into Planks (Allen, 81)

Seasoning may be the longest part of the process. This is because there is anywhere from 30-300% water content in a tree. This water evaporates through its life and during that process the wood begins to shrink. Along with the shrinking is also strengthening, framing is specified to have 15% moisture. However, there is no need to dry out a piece of lumber below 13% do to the fact that wood is hygroscopic, and no matter what, wood will absorb and release water due to humidity in the air. Surfacing will then smooth the edges, sometimes leaving two rough edges. (Allen)

At this point, transportation and storage of lumber is needed until it is used in the building process. "Wood is the only major structural material that is renewable." (Allen, 78) However,

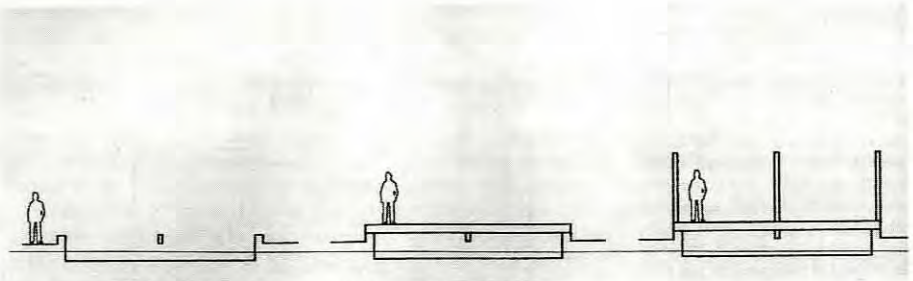

Indoor Lumber Yard (www.bourgetbros.com)

"Wood construction involves large numbers of steel fasteners of carious kinds. Because steel is produced by relatively energy-intensive processes, fasteners add considerably to the total energy embodied in a wood frame building." (Allen, 79)

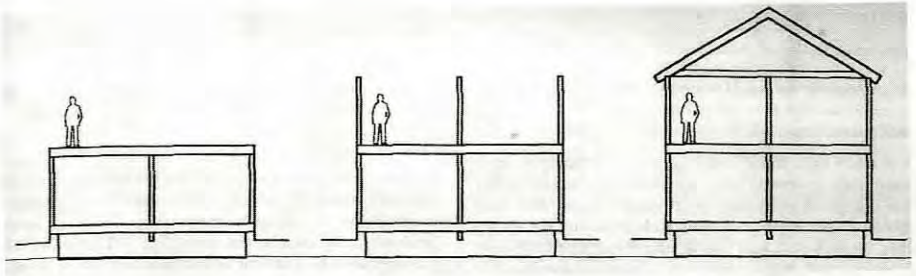
"If the wood frame of a building is kept dry and away from fire, it will last indefinitely. However, if the building is poorly maintained, wood components may decay and require replacement." (Allen, 79)

Conclusion

Each of these strategies rethinks the use of material the building process. While each of these strategies strives to produce a more sustainable building system, the strength of a process is when it is represented in a legible way. Strategies which get implemented and can not be touched, seen or experienced in some way don't exist to the user. It is important to educate people of what is and is not sustainable about the building process so they can understand it and implement it in their own consumption.



Conventional Building Process (Allen, 146-147)



Rethinking The Learning Process

The learning process is complex and multifaceted. There are three different learning styles. They are visual, auditory and kinesthetic. Each learning style deals with a different type of sensory learning. Not all people learn in the same way, some rely heavily on one type while others utilize all.

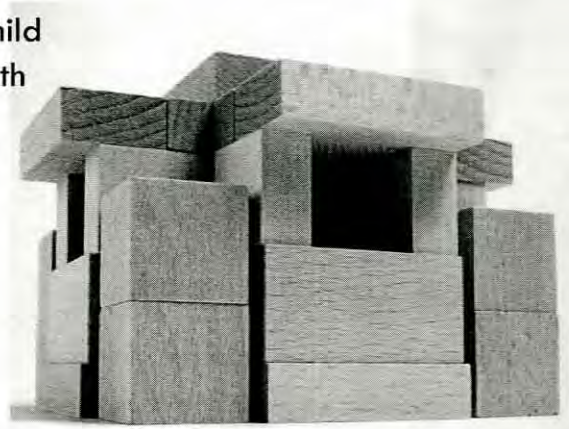
Froebel Blocks

"The Gifts will teach the child to use his (or her) environment as an **educational aid,** secondly, that they will give the child an indication of the **connection between human life and life in nature;** and finally that they will create a bond between the adult and the child who play with them" (Liebschner, 82)

Froebel blocks are an educational tool which allow for exploratory learning. They were most notable used by Frank Lloyd Wright and are claimed to have been a keep to his early architectural discoveries. Hands on learning tools, such as the Froebel blocks are an effective way of self directed teaching.

Montessori Method

The Montessori Method is a child-centered, alternative educational method based on the child development theories originated by Italian educator, Maria Montessori, in the late nineteenth and early twentieth centuries. (Röhrs)



These are some of the characteristics of the Montessori Method:

- Children are capable of self-directed learning.
- Teachers are "observer" of the child
- Children are masters of their school room environment
- Children learn through discovery, so didactic materials with a control for error are used.

•The hand is intimately connected to the developing brain in children. Children must actually touch the shapes, letters, temperatures, etc. They are learning about—not just watch a teacher or TV screen tell them about these discoveries. (Montessori)

Applying these methods to a building which serves to educate its users of the building process suggests that a building should allow for discovery through the placement of stimulating tangible objects. Through the way that space is represented a user can learn by observation and detection instead of straight forward representation.

Architecture as a Tool

"Coming to grips, over the coming decades, with the significant problems facing our environment will require action on many different fronts. Schools have an important role to play in this effort. As places of learning, our schools not only should be green in their construction and operation but should themselves be teaching tools. Many of the features incorporated into green schools – from renewable energy and day lighting systems to storm water infiltration practices- are ideal hands–on laboratories." (Wilson)

This idea of a "hands-on laboratory" is one that exploits the architecture and reveals the working aspects of a building. There is a multiplicity of ways in which architecture can aid the learning process. Through design one can gain a better understanding a passive solar heating, water collection and re-use, building construction and material life-cycles.

"Rather than being designed to be totally isolated from the ecosystems, the built environment should be designed to integrate and have compatible symbiotic relationships with ecosystems." (Yeang, 61)Architecture doesn't need to hinder the natural ecosystem, it can aid in its sustainability and through that process should teach of the interconnectedness between nature and human influence.

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Learning from Nature

"Sustainable design endeavors to create the healthiest, most nourishing places possible for people without diminishing the ability of nature to provide nourishing places for the rest of creation and for our own species in the future." (McLennon, 46)

"Study nature, love nature, stay close to nature. It will never fail you."
– Frank Lloyd Wright

To promote sustainable design, sustainable life styles and an overall comprehension of the anthropogenic effects on climate change, one must first learn to appreciate nature and all that it provides. A forest houses more than renewable energy in trees, it also creates habitats. These habitats are a result of day lighting, moisture and nutrients found in soil. Deer, birds and small animals such as porcupine find their home in these habitats. Architecture can aid in the display of this beautiful resource.

"Nevertheless, the built environment has effects over a specific segment of space and time. By its physical presence, the built environment, no mater how well designed, will intrude upon, displace spatially, and alter the ecology of the ecosystem on which it is located." (Yeang, 20)

This fact is undeniable, but what is not stated is that architecture can also, through education, promote human action toward reducing consumption and limiting production of greenhouse gasses, ultimately reducing the negative anthropogenic effect on ecosystems.

"Sustainability implies long-term viability. As the term sustainable is used today, sustainable developments, culture, lifestyles or whatever, are those that do not overtax the resources and regenerative capacities of the earth, thus leaving for future generations as much of nature's bounty and beauty as we enjoy now." (Buchanan, 11)

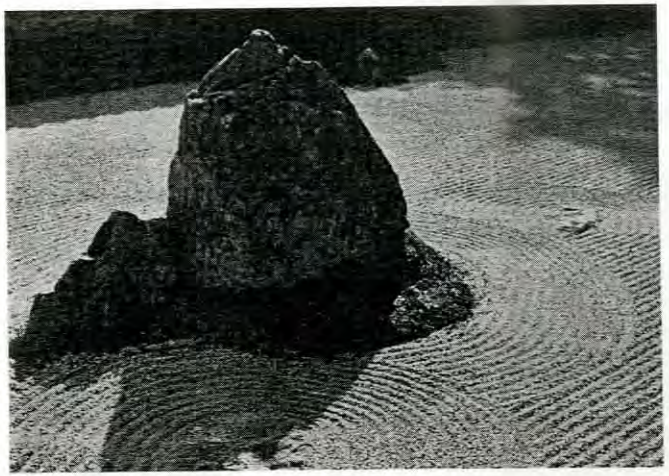
Children observing nature (Camp Chewonki, Maine)

Respecting Nature: Ise Shrine

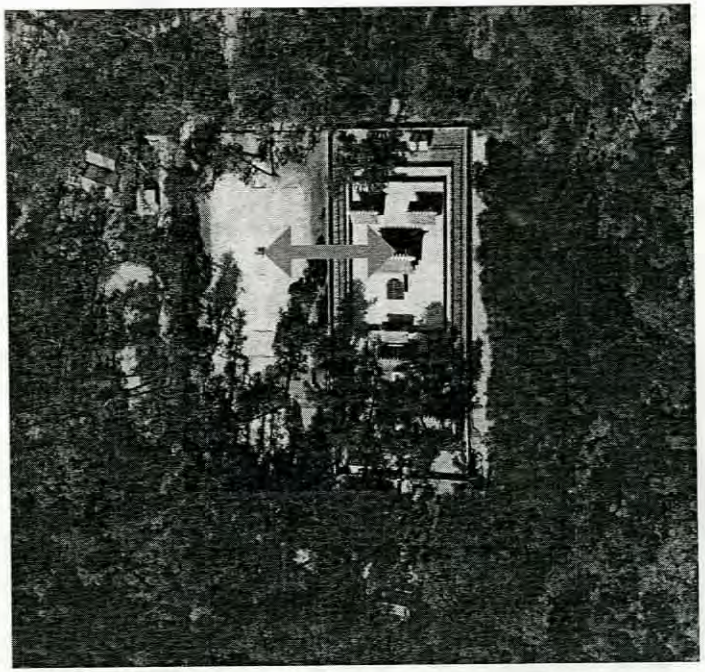
"The ancient Japanese sought their symbols and divine images in nature- in rocks, trees, and water. This way of looking at nature is still at the very core of the spiritual make up of the Japanese of today." (Tange, 19)

"This Japanese approach to making space tangible involves defining, marking of, and limiting space in nature, and it contrasts with the Western approach of erecting a single mass into space; the former expresses space on the horizontal, two-dimensional plane, the latter on the vertical, three-dimensional plane." (Tange, 33)

Japanese religion holds nature in high esteem. This is where beliefs stemmed from. Importance is given to natural features, both altered by man and in their original state. These shrines are all juxtaposed next to nature, surrounded by its immensity, its forests and its water. By respecting nature, the Japanese craftsmen have been able to absorb an enormous amount of knowledge of how nature operates and changes. Just as nature goes through cycles, the Ise shrine goes through cycles. The natural resources that surround the sacred site are also placed within it and special significance is given to placement, connections and adjacencies.



Rocks hold particular spiritual importance (Tange)



Conclusion

Architecture which creates experiential space, which allows the user of self directed learning, can educate people in some cases more effectively than a text book or a video. People learn through touch, smell, and sight, and by cultivating those sense and allowing them to absorb a space, architecture and nature, and the combination of the two can act as a very successful teaching tool.

Program/ Intent

Didactic Architecture

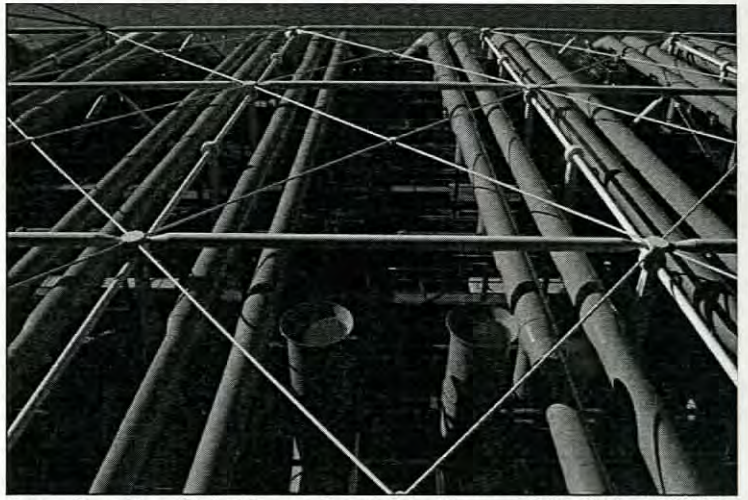
Program: Environmental Education Center and Overlook

Visitors: Tourists, 30- 200 a day
Staff: 2 full time, 4-7 volunteers
Square Footage: 8,000 sq ft

Didactic architecture is instructive. Architecture which teaches about its own process of existence is one that is didactic in more than one way. It exposes its connections and reveals its production. By reversing the common conception of architecture from one that is concealed to one that is open, the user can simultaneously learn about what it is and how it became.

"Exemplified by the work of Richard Rogers and Renzo Piano, the "hi-tech" style of the Lloyds of London and the Centre Pompidou buildings also illustrate many DfD principles. These designs turn the traditional layers of internal core mechanical and utilities system inside-out. Using structure as an armature upon which to place mechanical, plumbing and electrical systems, these designs provide for open flexible floor plans within the envelope of the building structure." (Ciarimboli, 5)

Inasmuch as Lloyds and the Centre Pompidou exposing their "insides" will educate the user of the processes which take place within a building, a building which represents its process of completion will educate the user of its lifespan, both past, present and future.



Centre Pompidou. Digital image. Essential Architecture. Web. 9 Nov. 2009. <http://www.essential-architecture.com/PA/005-centre-pompidou-a.jpg>.

Audience

Tourists

The tourists which visit the area every year. Primarily adults.

With 80% of the US's population living in urban areas there is a need to educate people of rural forest industry techniques and the implicit relationship between the built environment and the natural one. There are thousands of tourists which come to the area every year to play golf, ski, hunt, fish, snowmobile and hike, these people would benefit from an educational, visitors center which through its construction techniques and design educated them of material life cycles and the process of a buildings formation.




Each season a new group of tourists come to the area. They all have a different agenda, but each is traveling hundreds of miles to enjoy the natural resources that a rural location has to give them. These vacations last anywhere from a weekend to a whole season, everyone gets outdoors in some way or another, whether it is to take a picture, ride a snowmobile to hike 10 miles a day, these people have an invested interest in nature already, but lack the knowledge of their role in the process.

The percentage of people living in urban areas is growing every day

Program

Environmental Education Center and Overlook

The building is going to act as a node for tourists to learn. The Environmental Education Center and Overlook will draw in visitors because of its shear beauty and location. Through successive programs within the center the inhabitant will be informed of logging's role in a sustainable world and the process of construction and building formation. The building will consist of roughly 8,000 square feet and will have 2-4 employees as well as space for tourist groups, individuals and students.

The Center will not only be a place of learning, but also a place of recreation. There will be connection to trails, terraces gardens and observation points. Each of these programs will be links visually and programmatically to the next "lesson."

An Environmental Education Center will benefit my thesis through its ability to implicitly teach and educate users of material lifecycles and their ultimate connection back to nature. The building delaminates the construction process, working backwards, resulting, not coincidentally, with nature.

The indoor program will include:

Visitors Center- 1,000 Sq Ft

Gallery- 1,500 Sq Ft

Cafe- 1,000 Sq Ft

Kitchenette- 300 Sq Ft

Offices- 200 Sq Ft

Bathroms- 200 Sq Ft

Classroom- 1,000 Sq Ft

Storage- 200 Ft

The outdoor program will include:

Nature Pavilion- 1,000 Sq Ft

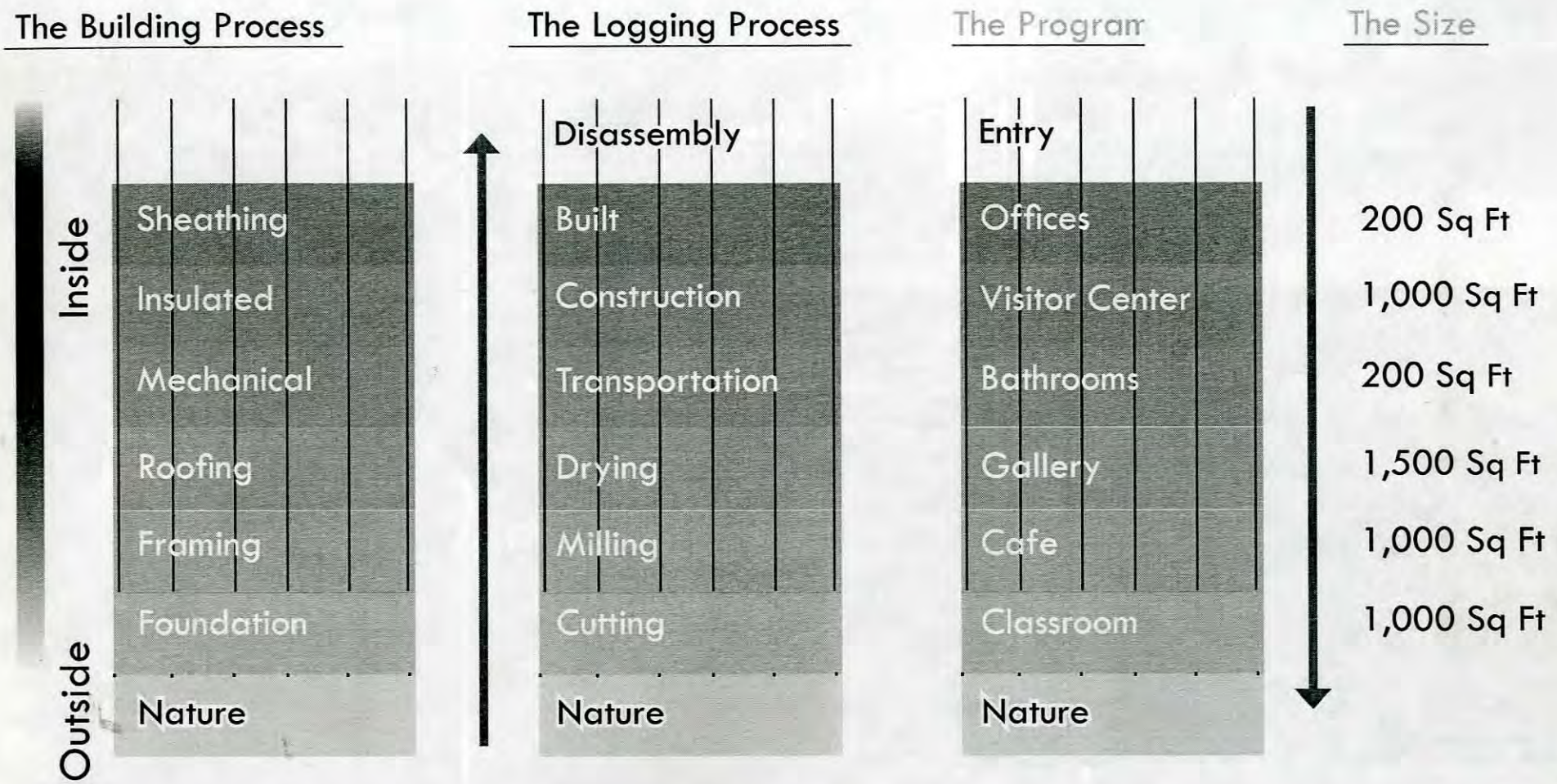
Terraces Gardens and Trails

Parking- 2,000 Sq Ft

Design Strategy

Dividing Stages

Both the construction process as well as the milling process can be divided into stages. This can be done through the layering of a building or the sequence of a building. Leaving each stage of the process incomplete is necessary to understand its role in the overall process.



Baldwin Hills Scenic Overlook

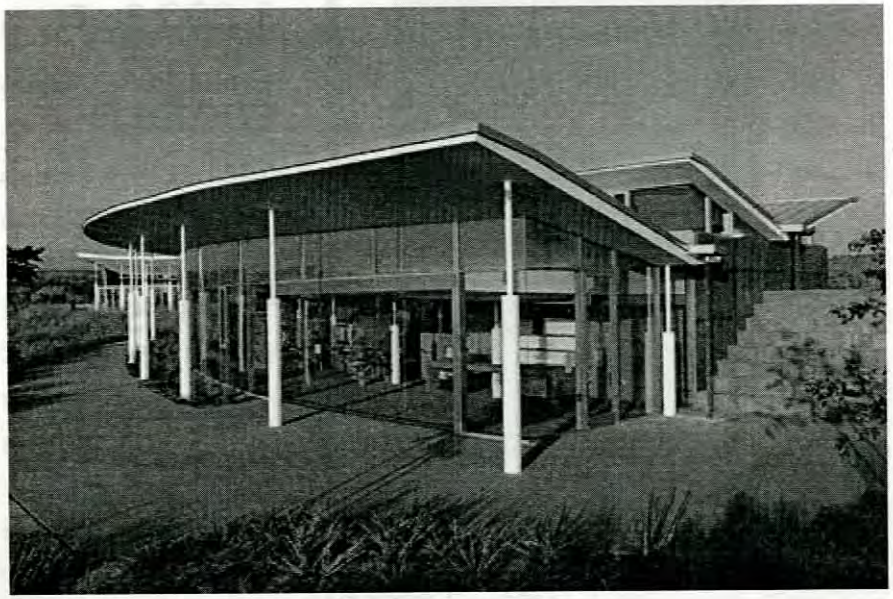
Culver City, California

Safdie Rabines Architects

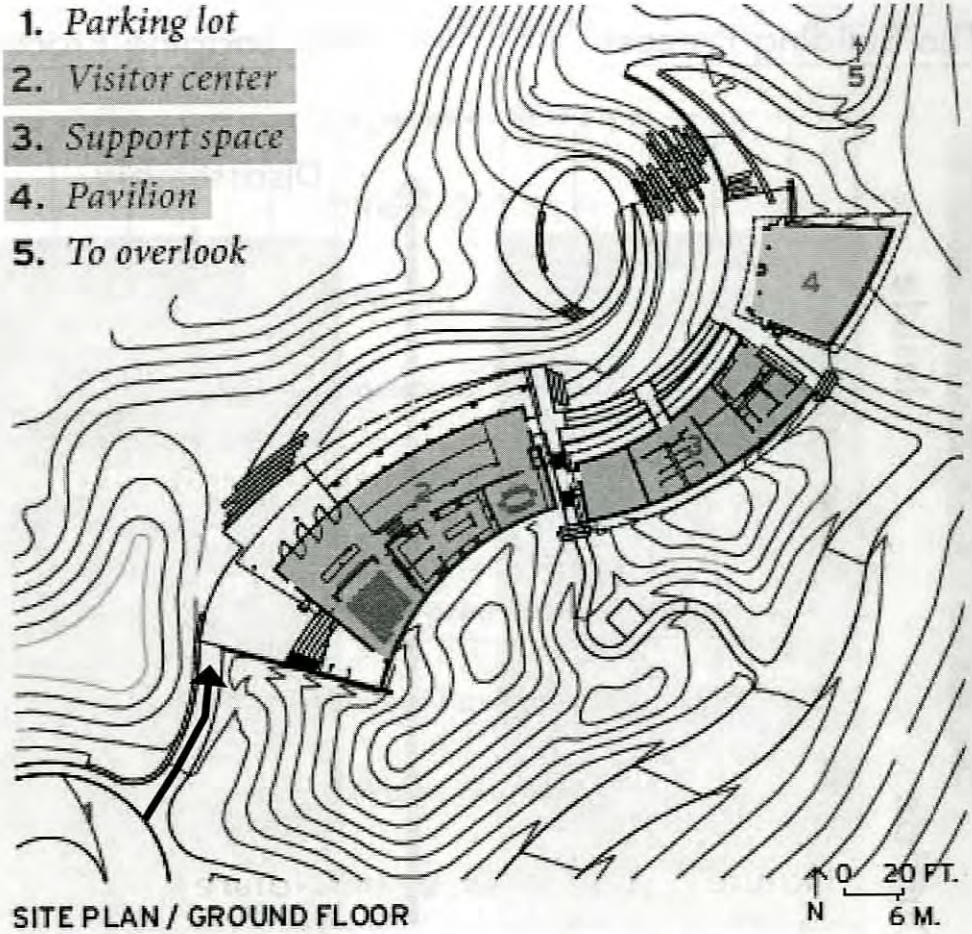
Gross square footage:
7200 sq.ft.

Total construction cost:
$7.5 Million

Program:
Visitor Center: 3400 Sq Ft
Support Space: 1790 Sq Ft
Pavilion: 1150 Sq Ft



1. *Parking lot*
2. *Visitor center*
3. *Support space*
4. *Pavilion*
5. *To overlook*



SITE PLAN / GROUND FLOOR

Source: Architectural Record

"The visitor center houses an exhibition on the area's ecology. Paths continues outside the building leading to lookouts"
- Sebastian Howard, Architectural Record

Image Source: Safdie Rabines Architects

Pavilion

Visitor Center

Support Space

Charles Benenson Visitor Center and Gallery at the Art Omi International Art Center

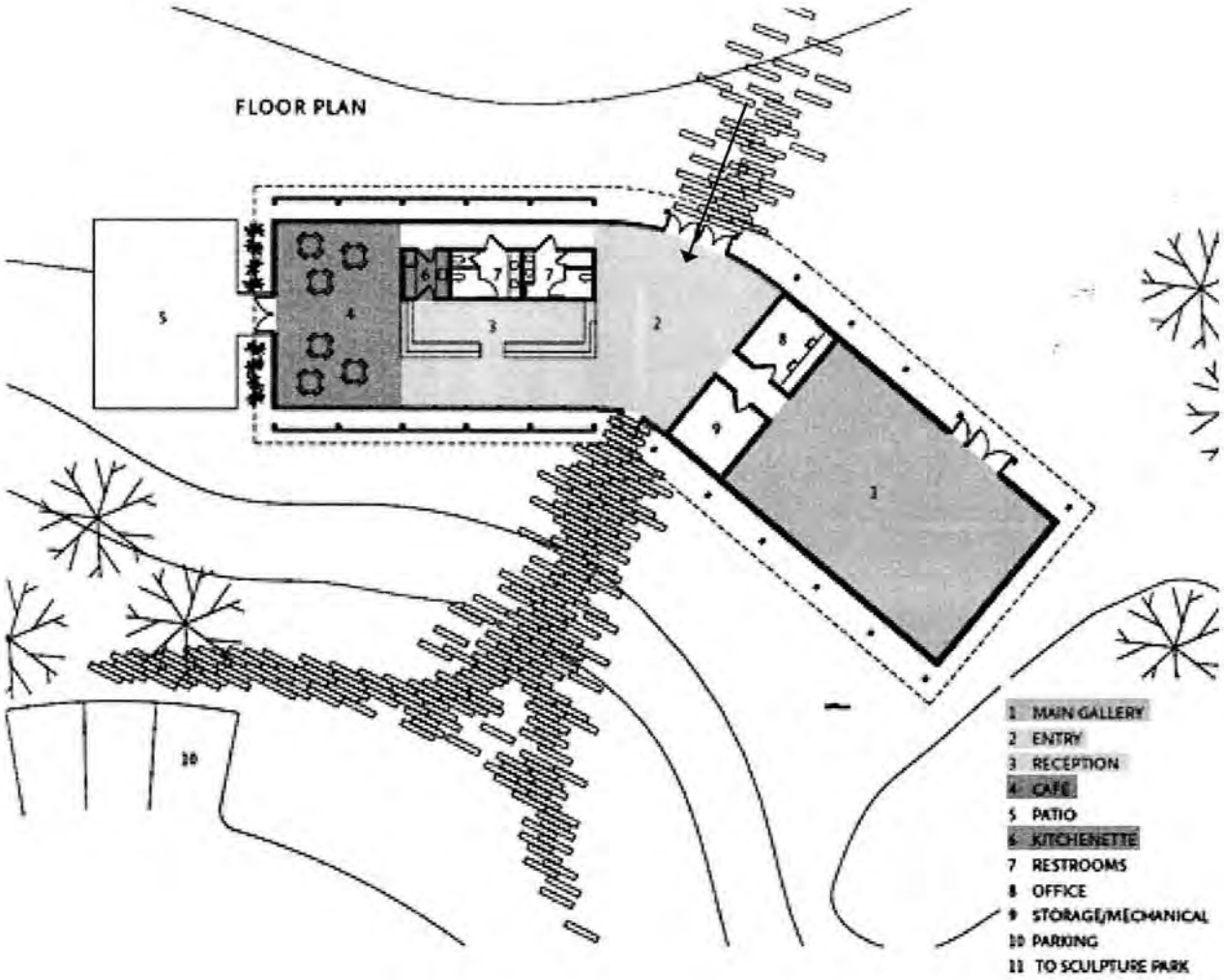
Ghent, New York

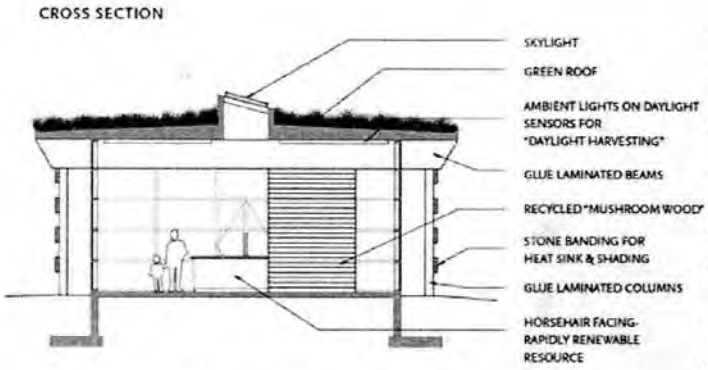
F:T Architecture + Interiors, PLLC

Gross square footage:
4200 sq. ft.

Total construction cost:
$1.2 Million

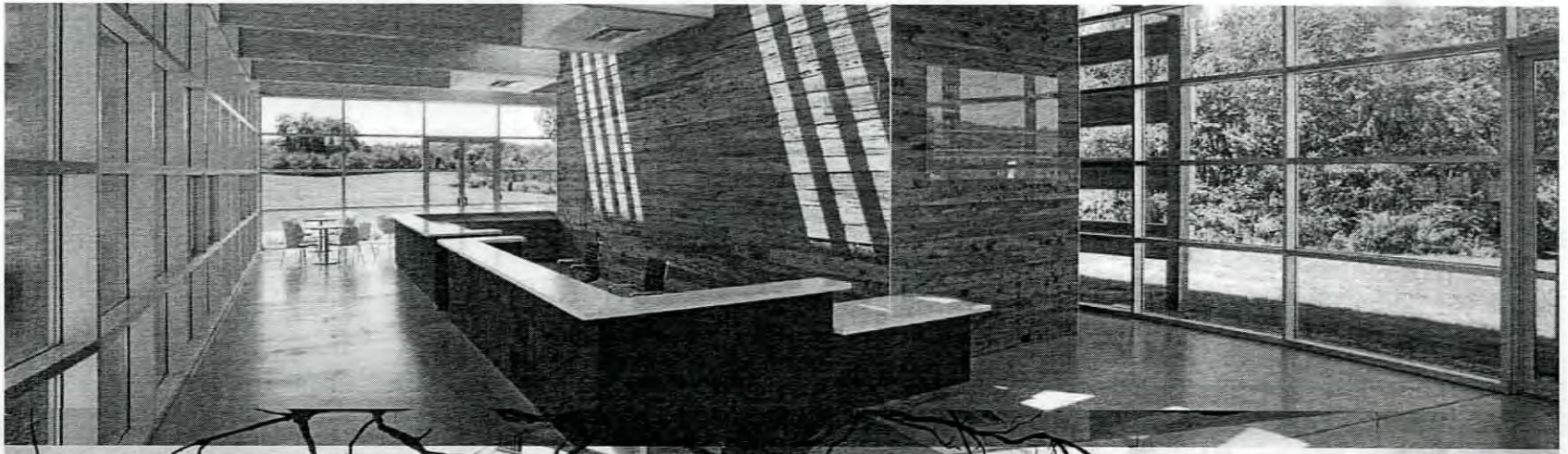
Program:
Gallery / Exhibit: 1,470 Sq Ft
Entry / Reception: 1,340 Sq Ft
Cafe: 820 Sq Ft
Offices: 130 Sq Ft
Storage: 130 Sq Ft
Bathrooms: 210 Sq Ft





Source: Architectural Record

Reception



Gallery

"An indoor gallery houses interior exhibitions and serves as a venue for lectures, concerts, and public programming in the arts."
- Architectural Record

Cafe

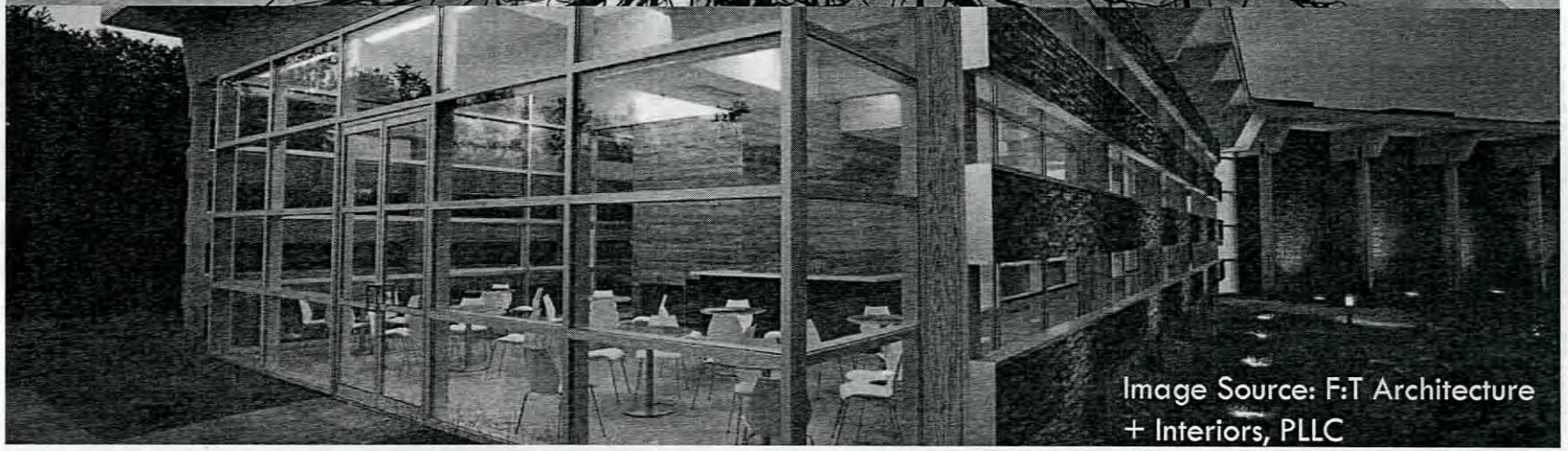


Image Source: F:T Architecture + Interiors, PLLC

Lichterman Nature Center, Loewenberg Visitor Center

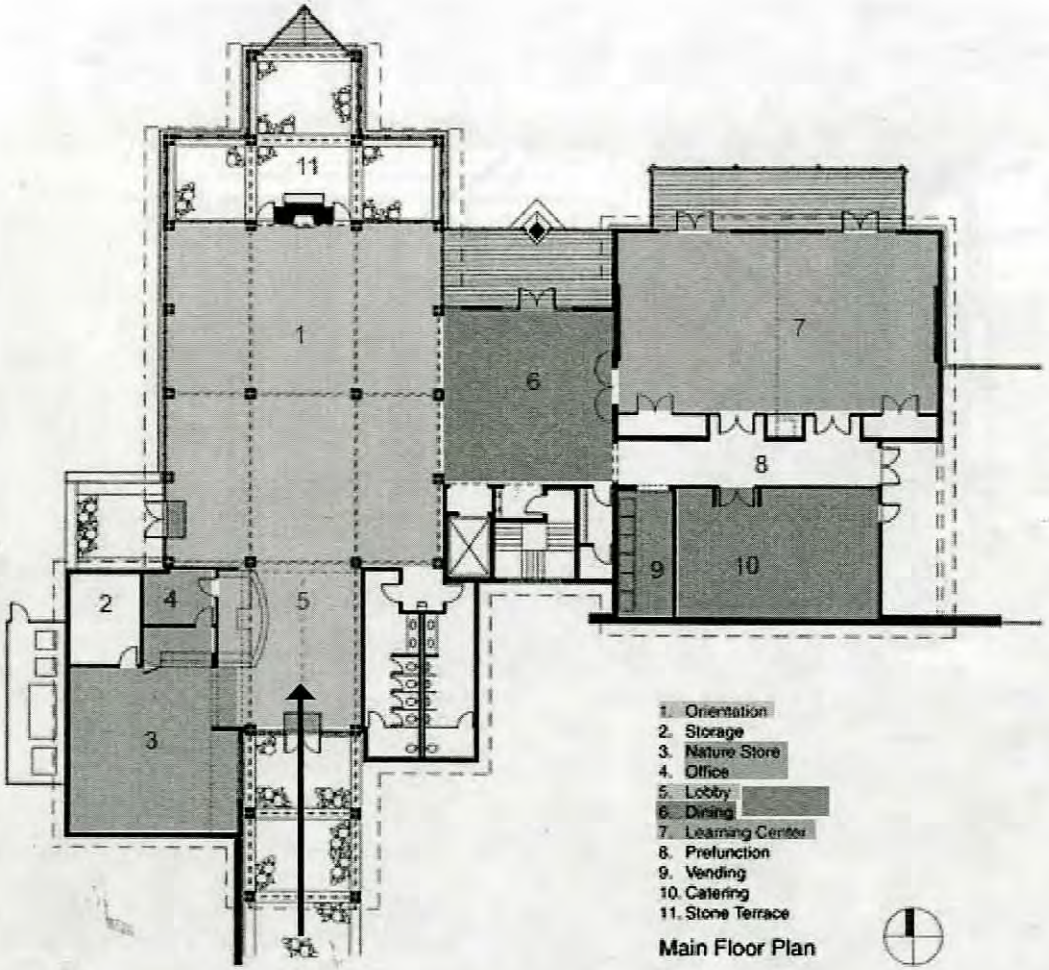
Memphis

Williamson Pounders Architects

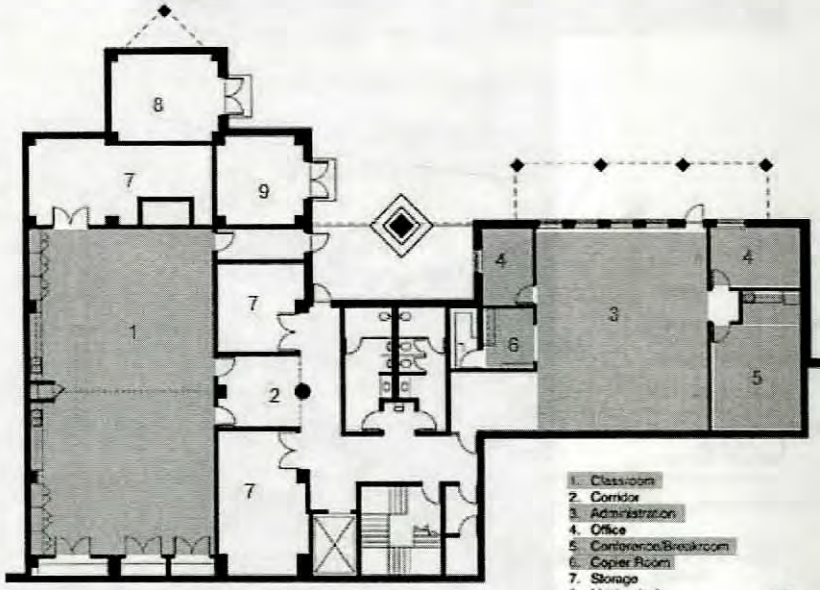
Gross square footage:
16,000 sq ft

Total construction cost:
$3.2 million

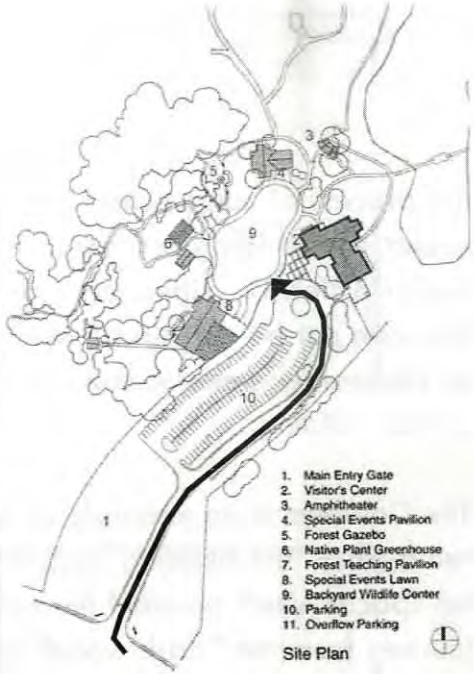
Program:
Lobby, Orientation and Exhibit Space: 4,000 Sq Ft
Classrooms: 4,100 Sq Ft
Food Related Areas:2,000 Sq Ft
Offices/ Store: 3,200 Sq Ft
Storage, Stairs, Bathrooms: 4,700 Sq Ft



Main Floor Plan



Lower Floor Plan



Site Plan

"Natural materials are expressed throughout the building. Wildlife exhibits fill the large orientation room and introduce the visitors to the three natural environments of the nature center: the forest, the meadow, and the pond."

Sequential Design

Sequential design will aid in the buildings ability to express the process of construction and formation. Unlike other processes, the building process is one that must happen in a particular order. The siding can not go on before the framing; a tree can not be cut into planks before being cut down and just as these stages must occur sequentially, so must the experience of the building.

The Danteum is an example of a building which is designed to tell a story. The building consists of a sequence of monumental spaces which parallel the narrator of the Divine Comedy's journey from the "dark wood" through hell, purgatory, and paradise. It uses architecture as a way to represent a piece of literature. Like the Danteum, a design which breaks down and separates the process it is exploring, will be more successful than one that exposing simultaneous stages at once.

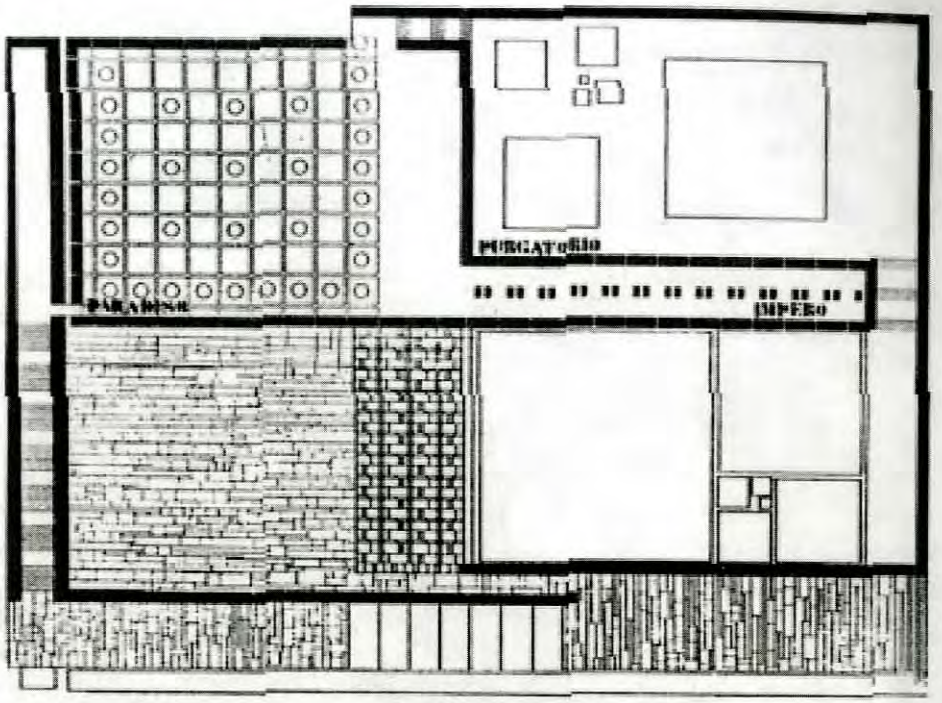


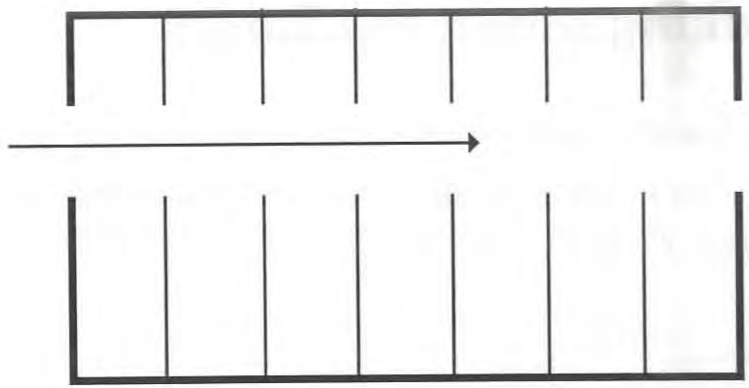
FIG. 32. Plan at 100m; top level.

The Danteum exemplifies building as sequence, where each room is conceived as a part of a narration.

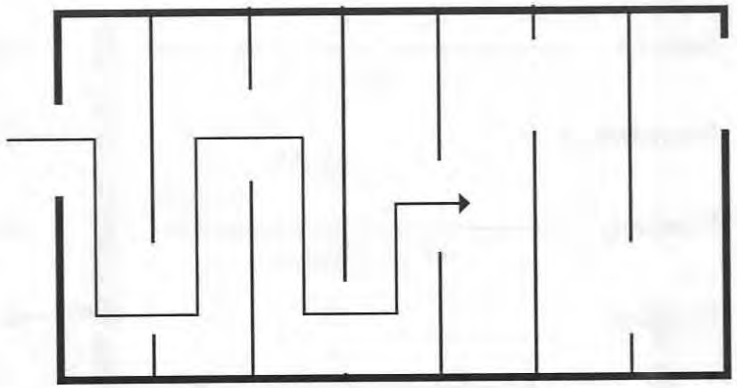
The Progression

A sequence which does not expose its progression will not be as effective as one that does. This is because when educating people of stages within an overall process it is crucial that one always has an understanding of their position within that process. If a person does not know where they started or where they will end and how many steps have been taken to that point, than the experience has lost its efficiency.

For example, a path which visually connects you to each successive stage of the progression will queue the user into how far they have to go. While a matrix will blur the distance traveled as well as the connections between each stage.



Vs.



Experience in Reverse

Instead of experiencing the process of construction and building formation in chronological order, one shall begin with what they know of the "built environment" and step backwards through its creation. This method of delaminating the building will ease the visitor through each stage and will result in nature and ultimately end with an overall scope of the process, looping around and viewing the building at a distance, its façade revealing its interior.

Breaking down the Stages

Each stage correlates with three things: An aspect of the building process, an aspect of wood production and a program. The architecture will expose and exaggerate the stages as well as juxtapose them against extremes. The site will take advantage of views, water resources and solar power.

Breaking Down of the Stages of Construction

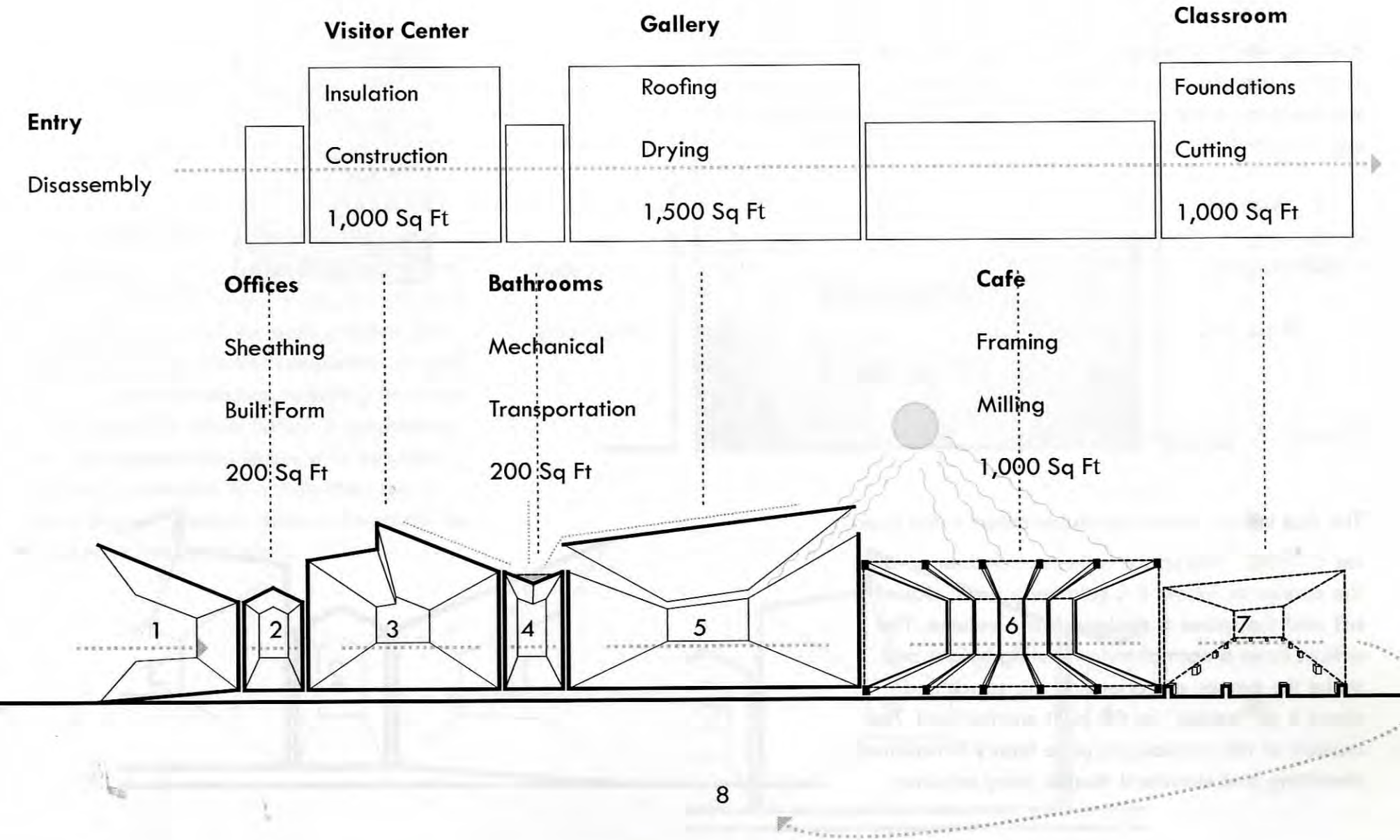
1. Nature
2. Foundation
3. Framing
4. Roofing
5. Mechanical/ Plumbing
6. Insulation
7. Sheathing

Break Down of the Stages of Wood Production

1. Nature
2. Cutting
3. Milling
4. Drying
5. Transportation
6. Construction
7. Built Form
8. Disassembly/ Re-Use

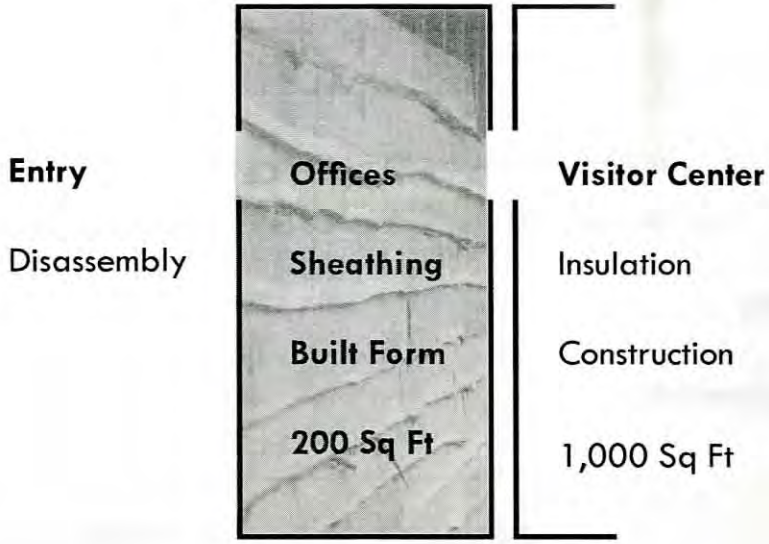
Experience of the Building

8. Nature
7. Classrooms
6. Cafe
5. Gallery
4. Bathrooms
3. Visitor Center
2. Offices
1. Entry


Visitor Center
Gallery
Classroom
Entry
Disassembly
Insulation
Construction
1,000 Sq Ft
Roofing
Drying
1,500 Sq Ft
Foundations
Cutting
1,000 Sq Ft
Offices
Sheathing
Built Form
200 Sq Ft
Bathrooms
Mechanical
Transportation
200 Sq Ft
Cafe
Framing
Milling
1,000 Sq Ft
1
2
3
4
5
6
7

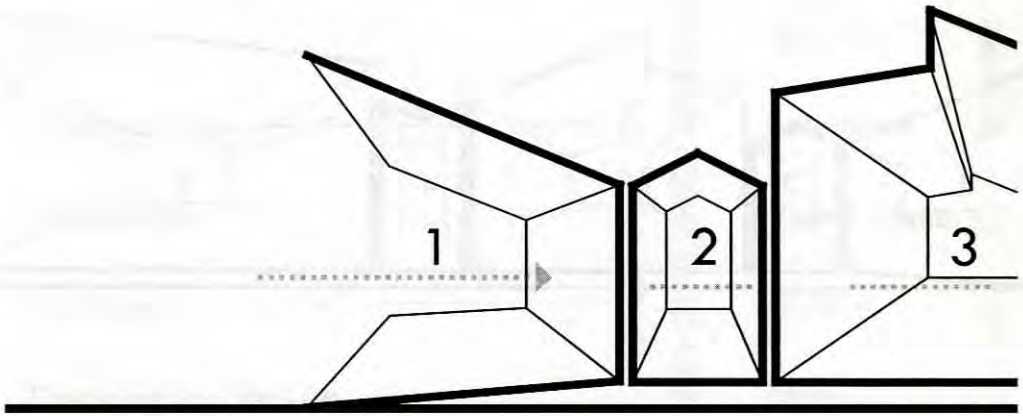
Stage 1. Entry

The entry to the building signifies the future. It is the point the building which is beginning to be disassembled and taken apart. This is a transition space between inside and outside. The Entry will be oriented towards the road and open towards the parking..

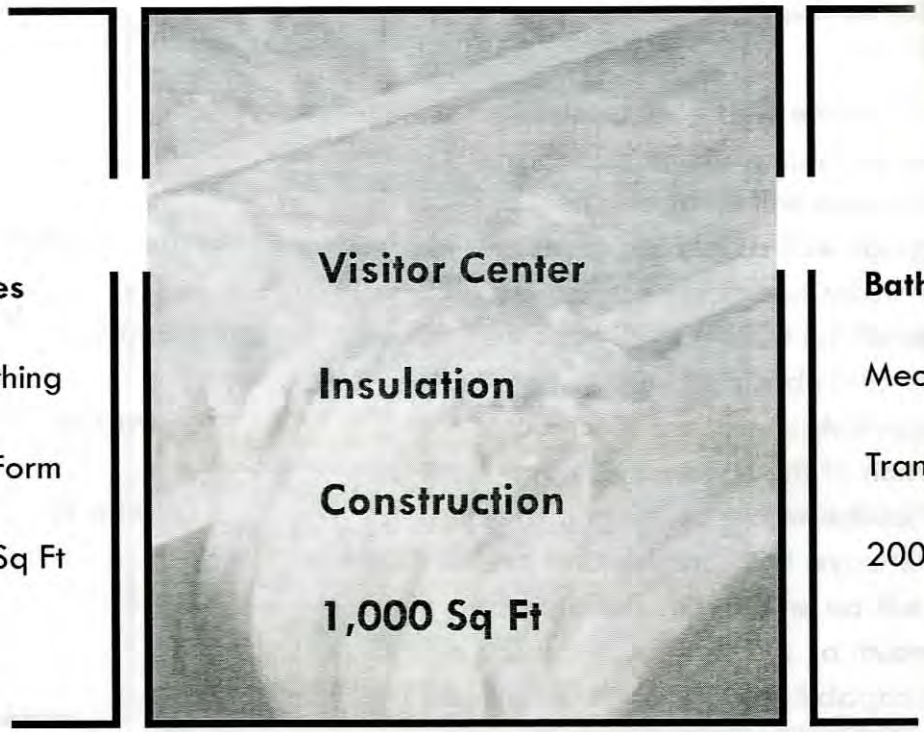


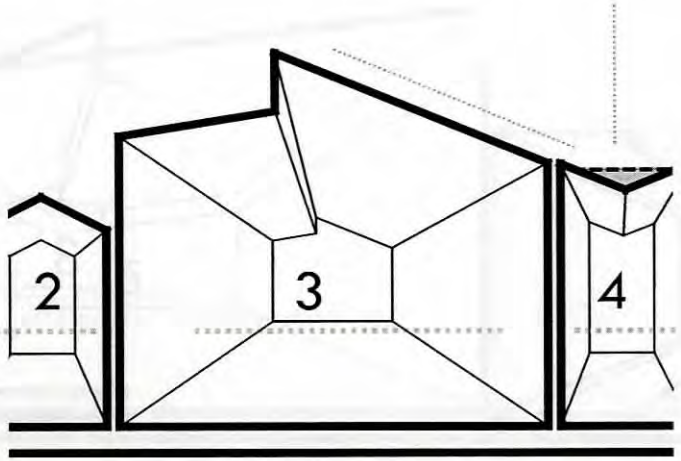
Stage 2. Offices

The first indoor space the visitor enters is the area for offices. This space is the most indoor of all the spaces to follow. It is relatively dark, closed off and the space is designed as a volume. The offices have a normal to low ceiling height and make the person experiencing this space understand it as "inside;" as the built environment. The outside of this portion will have highly articulated sheathing and standard double hung windows.



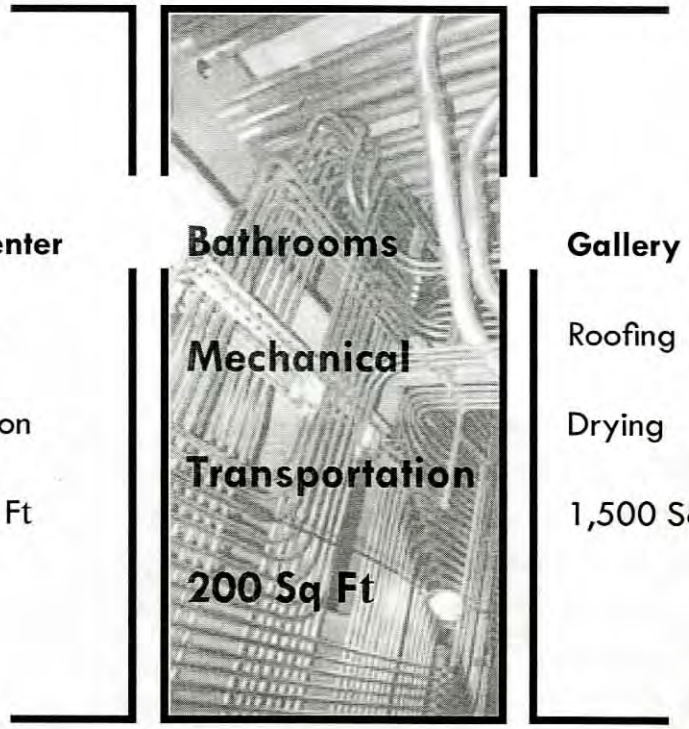
The visitor center is a much bigger space. Once you move through the offices the path opens into the visitor's center. Here is where tourists can get information on the area as well as learn about local logging practices. Not only is this an information center for Kingfield, but for western Maine and the surrounding areas. This space is also teaching the construction and insulation stages of the over process. This will be done by partial completion as well as a warm environment, including an open fire place. The visitor center is considered indoor; however this space also has much greater connection to nature than the offices. Bigger spans of glass will expose the panoramic mountain view.

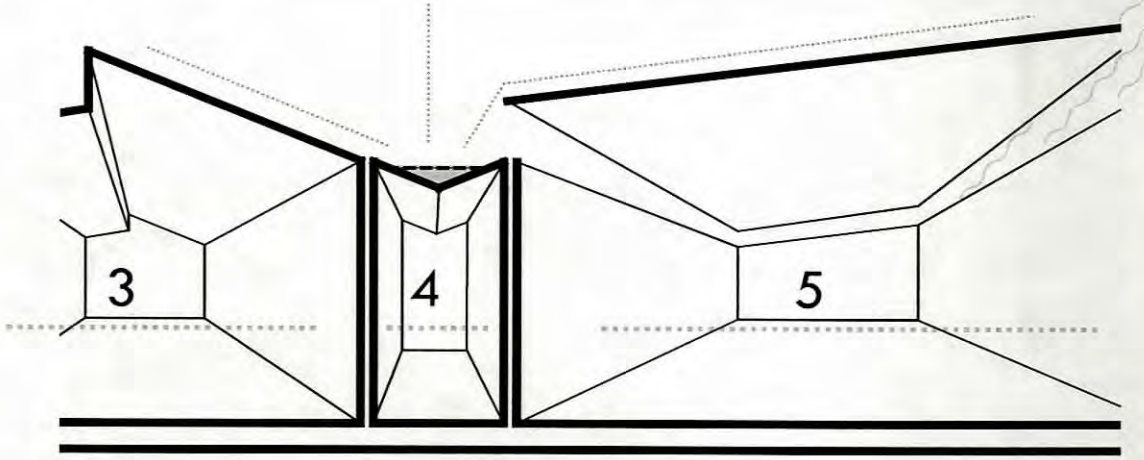




Stage 4. Bathrooms

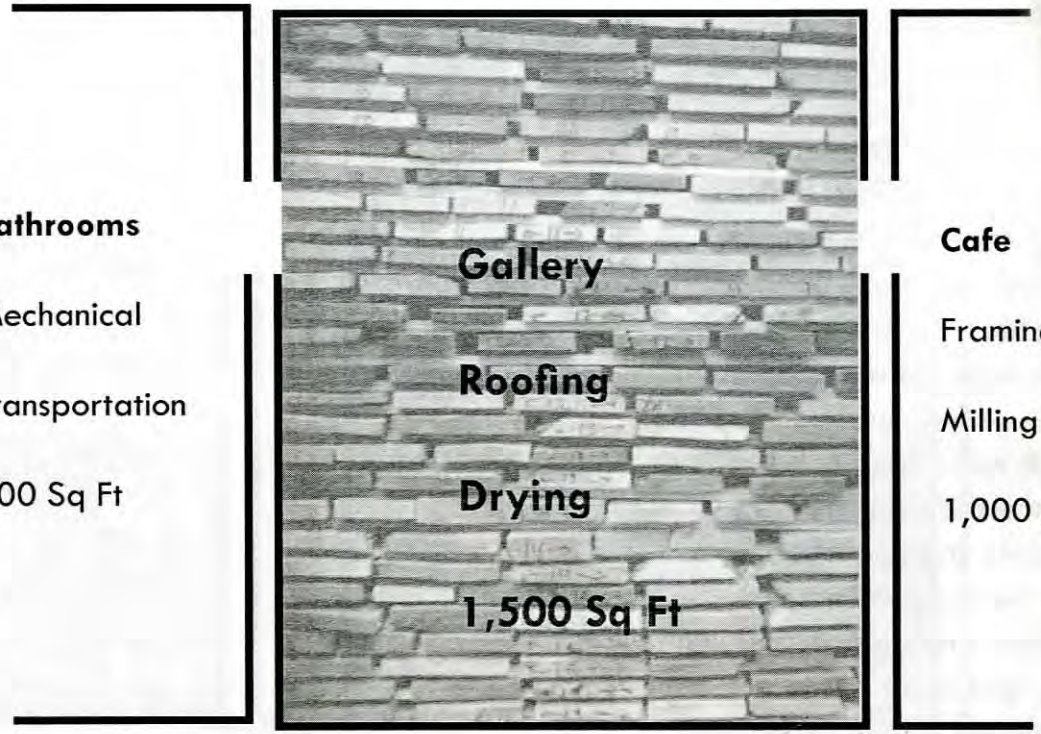
The bathrooms are where all mechanical, electrical, and plumbing culminate and are exposed. This space will utilize this network into the design as well as expose the recycling of gray water and rain water collection. Other sections of the building will filter the water into the catch basin located on the top of the bathrooms. Acting as the mechanical core, this portion of the structure will provide energy for the whole building. It will do this in multiple ways. Both passive and active systems will be employed. The site has a maximum amount of southern sun exposure as well as wind capabilities as it is placed on an open slopping site.

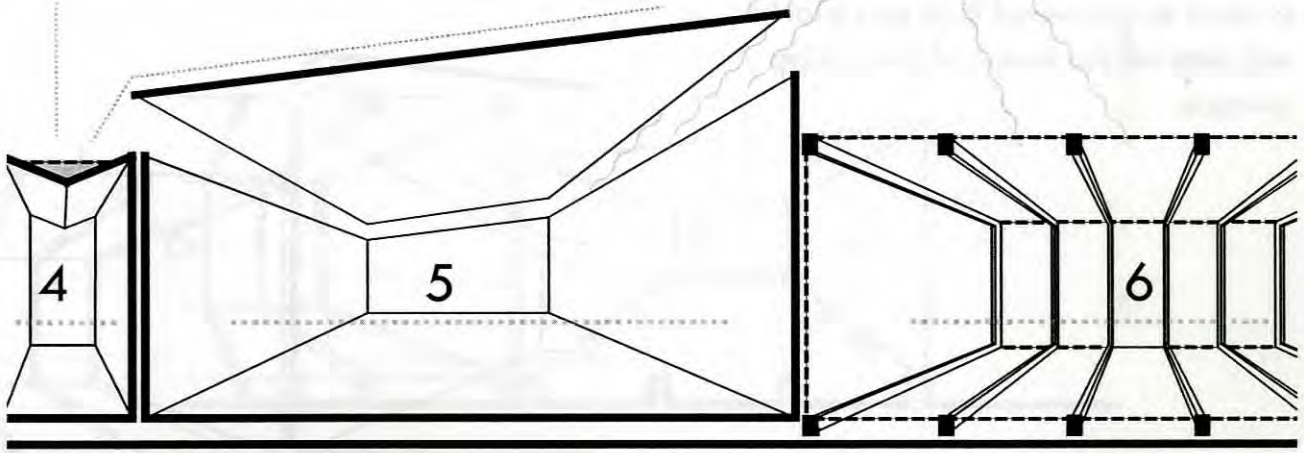




Stage 5. Gallery

The gallery is the largest space in the building. It is open and warm This space signifies the stage in con· struction when the walls are not yet up. There is only the frame and the roof. This will be expressed archite· turally through the use of glass and an elevated roof. The gallery will teach tourist's of the length of time that a piece of wood must dry and of its hygroscopic properties. The roof may house solar panels or the south facing wall may act as a gree house does to heat the space. The gallery will exhibit wood working tools and craftsmanship





Stage 6. Cafe

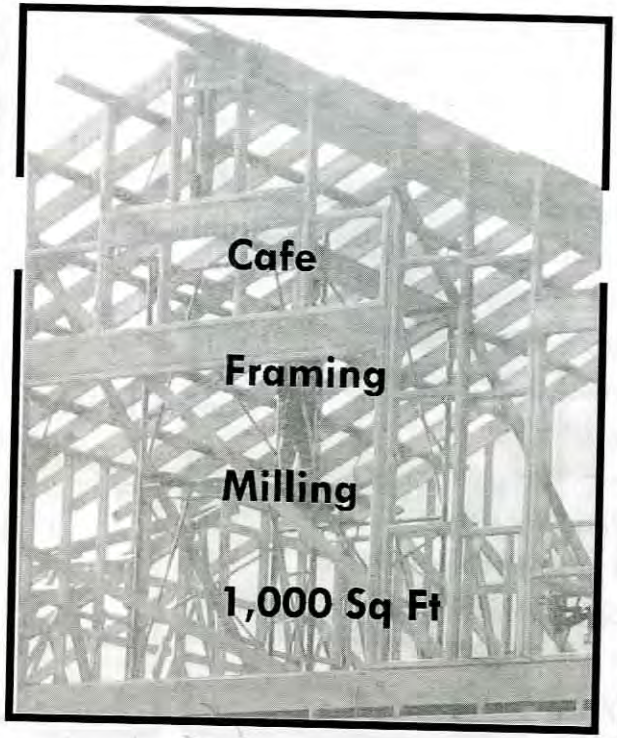
The cafe is provided for visitors so that they can come to the center for a cup of coffee or elongate their experience and include a meal. This space is teaching a lot, the framing systems which will be exposed and include well defined joints, as well as the milling process, which turns a log into a plank. At this point the building has almost been completely stripped down to its bare bones. The cafe will mediate between the inside and outside and will progressively get lower to the ground, just as the framing system starts from the ground up. The successive use of finished to unfinished logs and planks will play on the lesson of the milling process.

Gallery

Roofing

Drying

1,500 Sq Ft

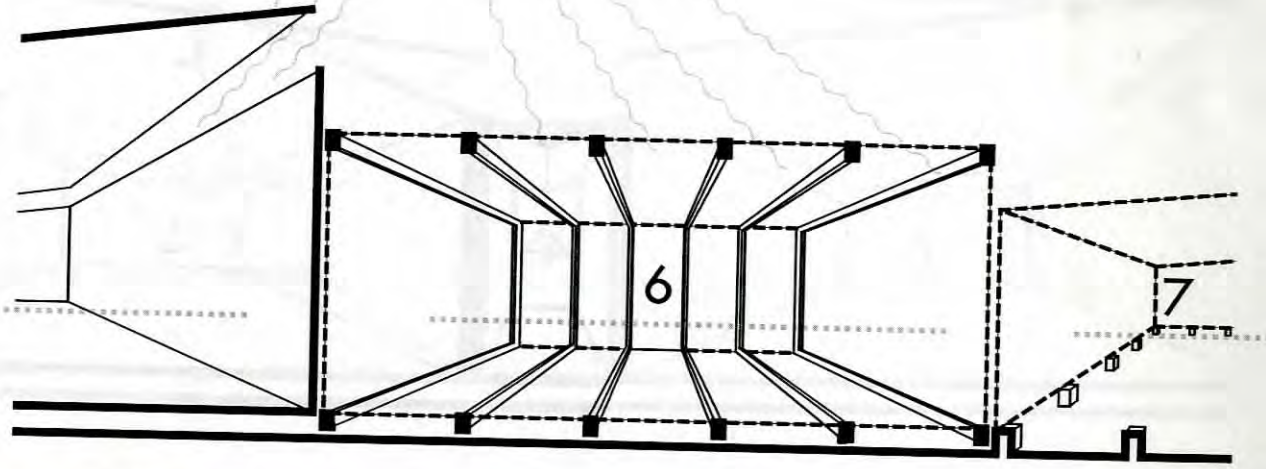


Classroom

Foundations

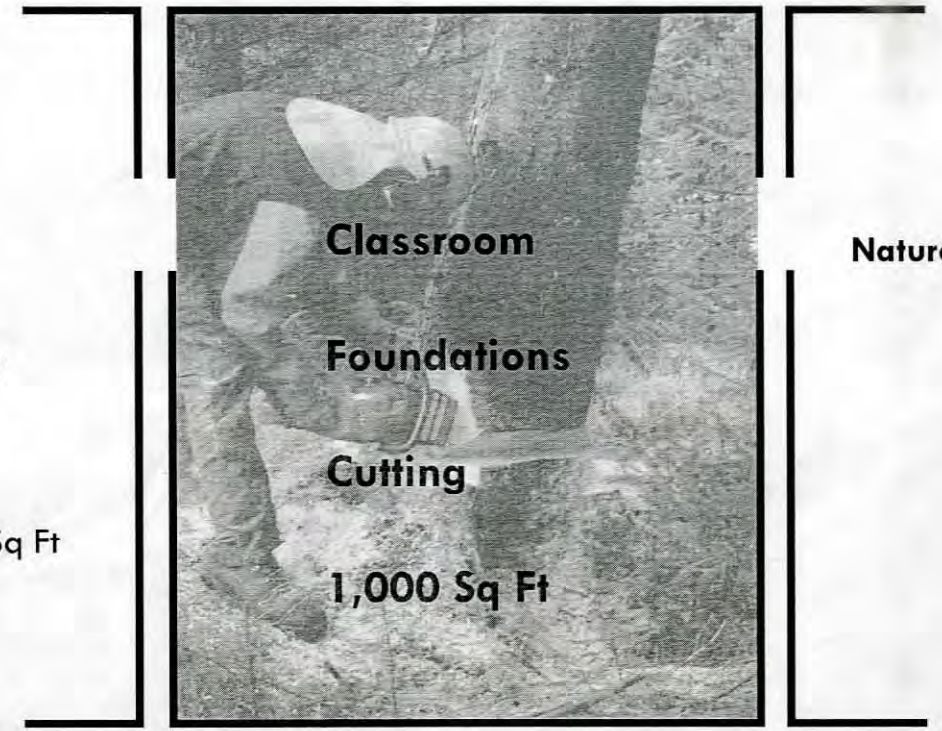
Cutting

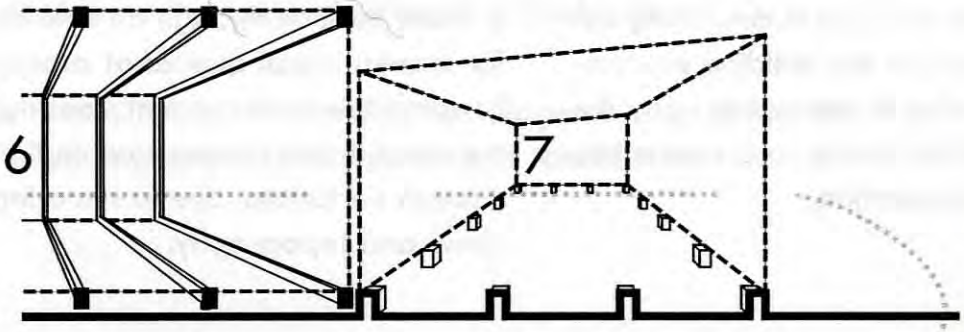
1,000 Sq Ft

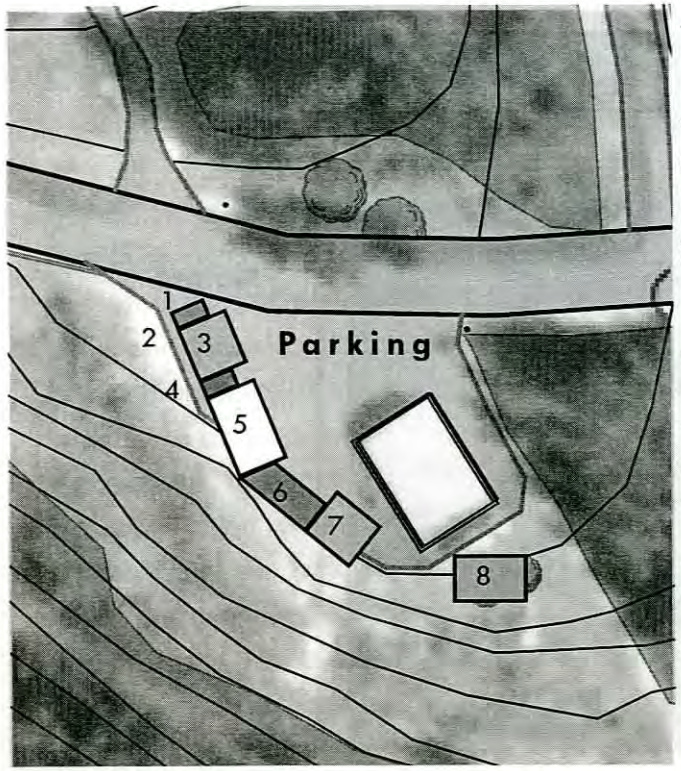


Stage 7. Classroom

This stage is the final stage in the building process, after the classroom is nature, which is the starting point of the entire process. The classroom is purposely at the end of sequence. From here one can see the culmination of each stage. This classroom is primarily outside, but is able to be enclosed in the winter months. The classroom will teach students and interested adults alike of the importance of sustainable forestry and nature's ability to regenerate her resources if taken and supplied at the same rate. Through using stumps as "foundations" and juxtaposing them against typical foundations one will learn of the need to rethink the way buildings touch the ground.

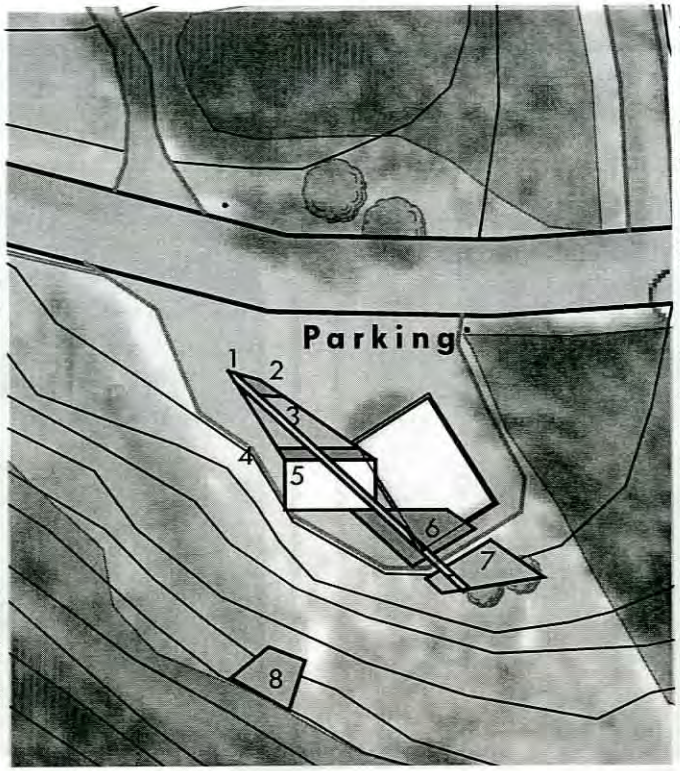






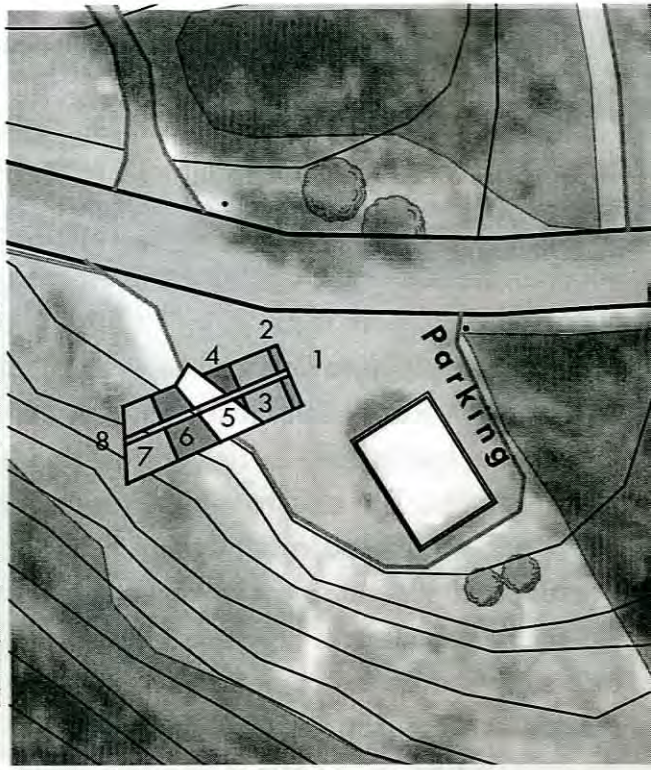
Arrange building along ridge

By arranging the buildings along the 'edge' the architecture can play a mediating role between nature and the building environment, however due to the topography the building would be unable to create a linear interior, visual connection.



Place building across foundation

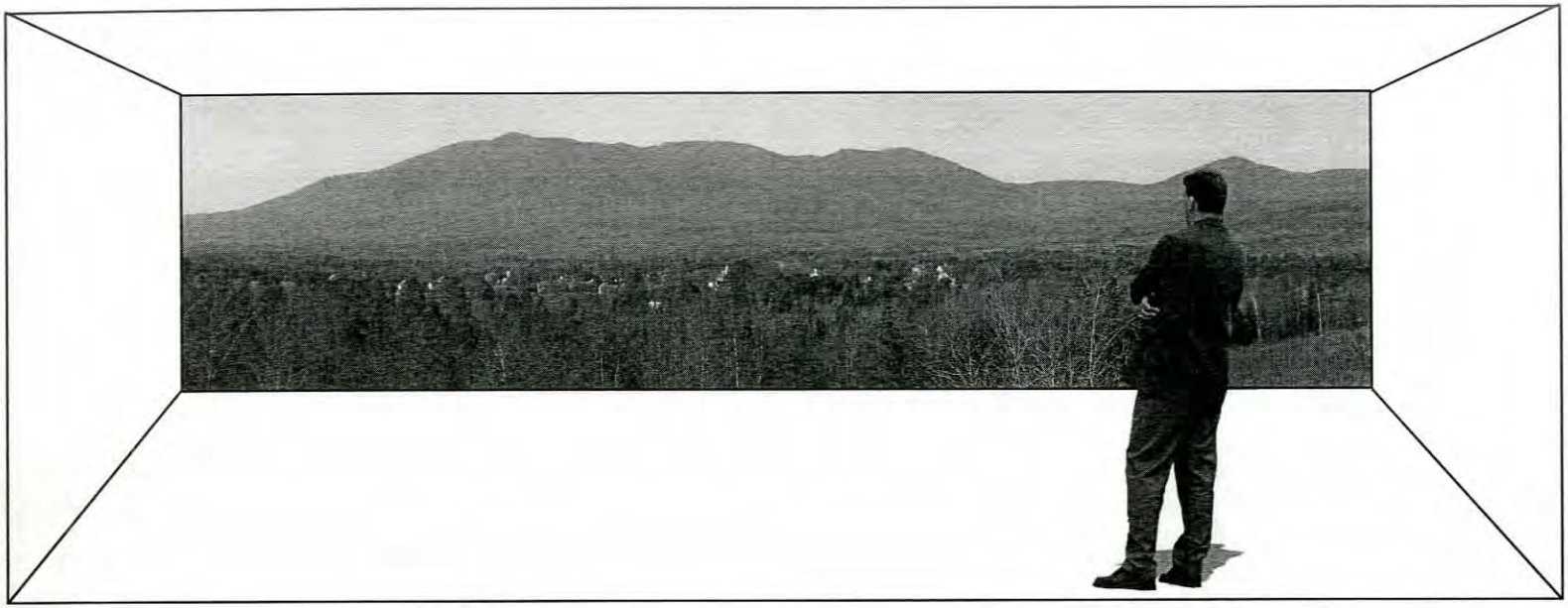
This opportunity allows all stages to align in a linear fashion through an interior corridor for interior visual queues of progression; however this arrangement does not resonate the same linear progression on the exterior through variations, due to sun orientation, views and topography.

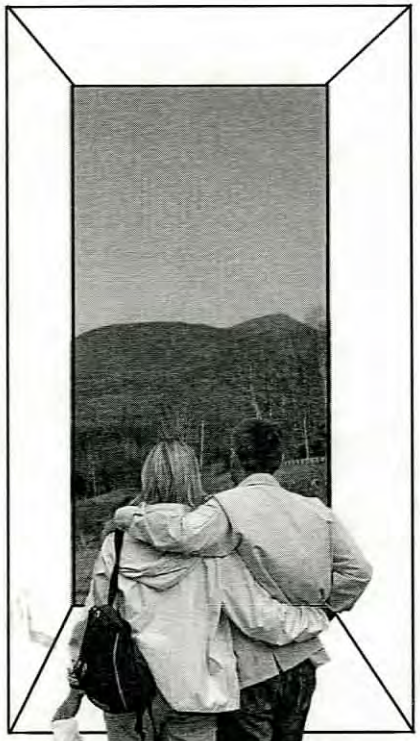


Building steps down into the hill

The layout creates a much more intimate relationship between the land and the building. As the building progressed it would vary in the ways it interacts with the landscape through foundation, raised platform or tunneling. However one down side to this arrangement is that when you get to the classroom one would have to make their way back uphill to the parking area.

1. Entry
2. Offices
3. Bathrooms
4. Visitor Center
5. Gallery
6. Cafe
7. Classroom
8. Nature





Framing Views

Framed views of Sugarloaf teach the visitors of the proximity of the mountain to Kingfield and the economic stimulus is has brought the area

Framed views of Mount Abraham with the village of Kingfield in the valley provides a comprehensive understanding of the location

Site

"Alison and Peter Smithson see the modern architecture of the "heroic" period as being created by machines: it is cubically formalized, abstracted in the interpretation of human activity, a perfect thing in itself, inserted and not rooted to the site, and made of "radiating" building materials." (Building Simply)

The connection to a site is crucial. It is the cyclical model between the built environment and natural one which this building is trying to exploit. To do this successfully the interplay of the building and its context will aid the success of the project.

A Rural Site

To expose the relationship between the natural environment and built one a rural site is required. This enables a better platform to reveal the dichotomy between the two. An urban site, while do-able, would not depict a clear relationship between the starting and ending points of the building process.

Site: Kingfield, Maine
44°58' 26" N 70°10' 3"W

Population: 1,103 people
Median Income for a Family: $37,614
Per Capita Income: $15,954.

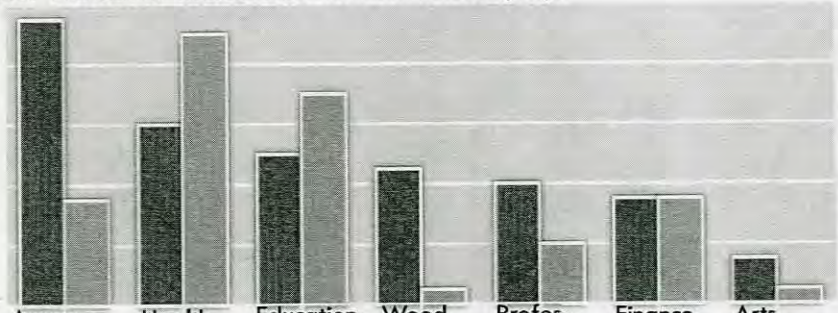
Proximity to Kingfield

Kingfield is located in the low land amongst the western mountains of Maine. This is where multiple rivers converge and the population has settled, due to water power for logging operations. The intersection of two primary roads, route 16 which runs East to West and route 27, running north to south, merge in the village center.

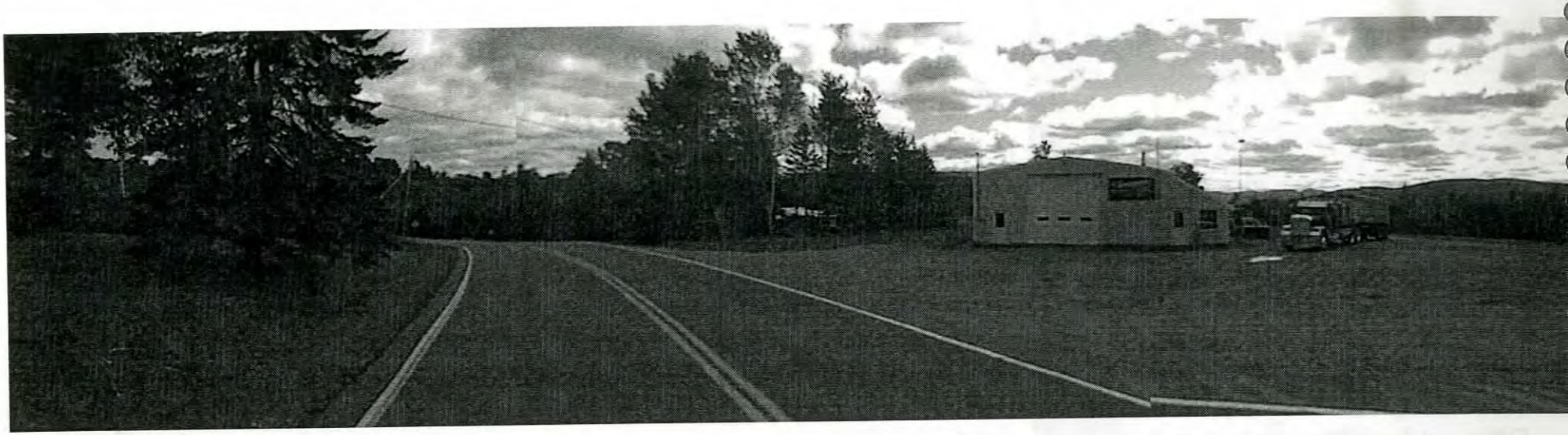
With a 44 degree latitude this site experience four very distinct seasons. The temperature ranges from zero to eighty degrees Fahrenheit. This shift in temperature and season provides four different opportunities for tourism. The winter months are known for the ski industry. Sugarloaf, the tallest ski resort in Maine is located 20 minutes away. In the spring people come to hike, in the summer visitors enjoy the surrounding lakes, golf and the comfortable temperatures, while the fall is known for hunting. Other outdoor activities include fishing, snowmobiling, and canoeing.

There are a little over 1,000 residence of Kingfield and those inhabitants primarily make a living off of tourism or the forestry industry. Kingfield is one of many towns in this area which have a wood turning mill. As this industry is waning, mills are closing down and the job market is shifting.

Most common industries for females (%):

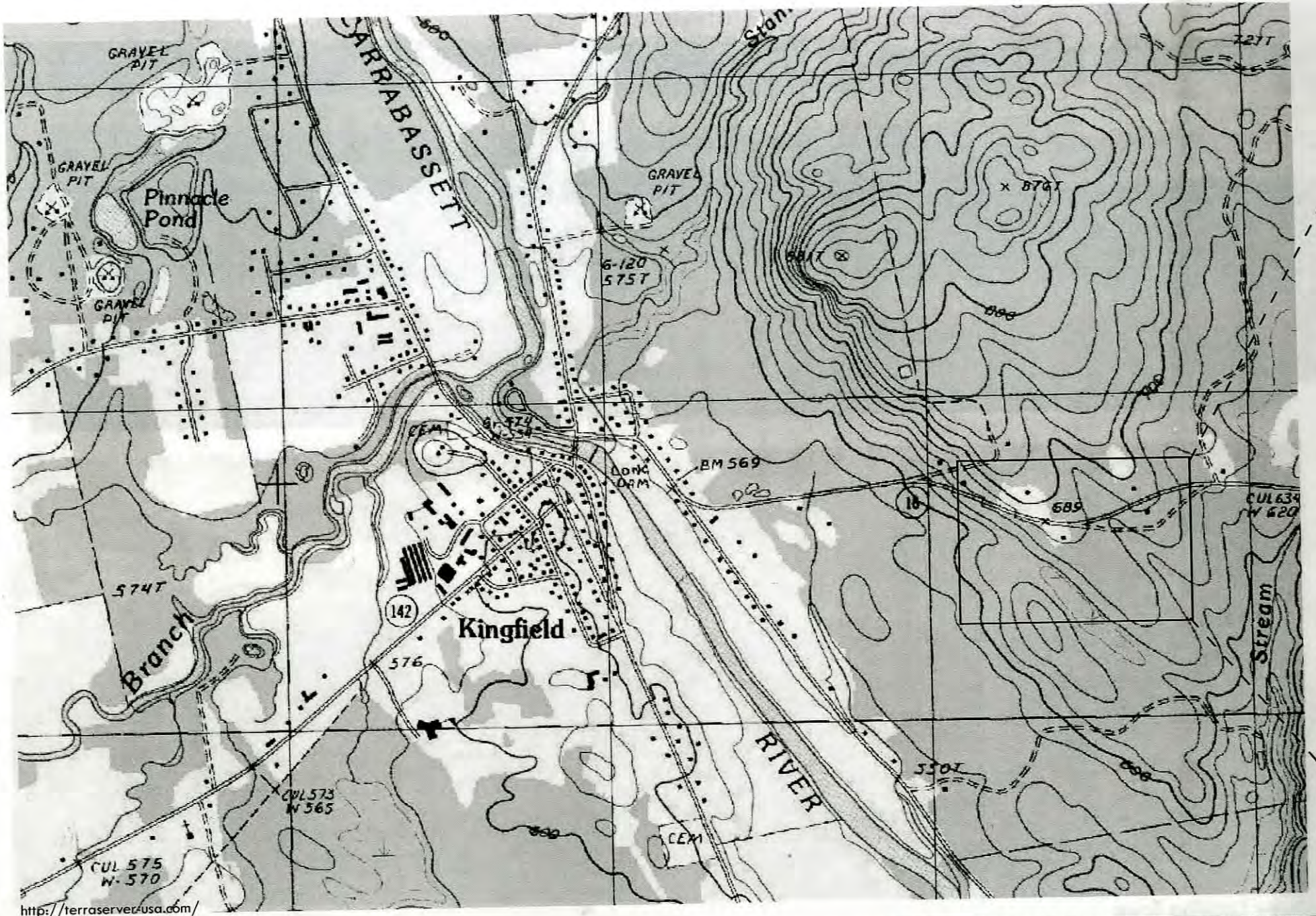


Most common industries for males (%)



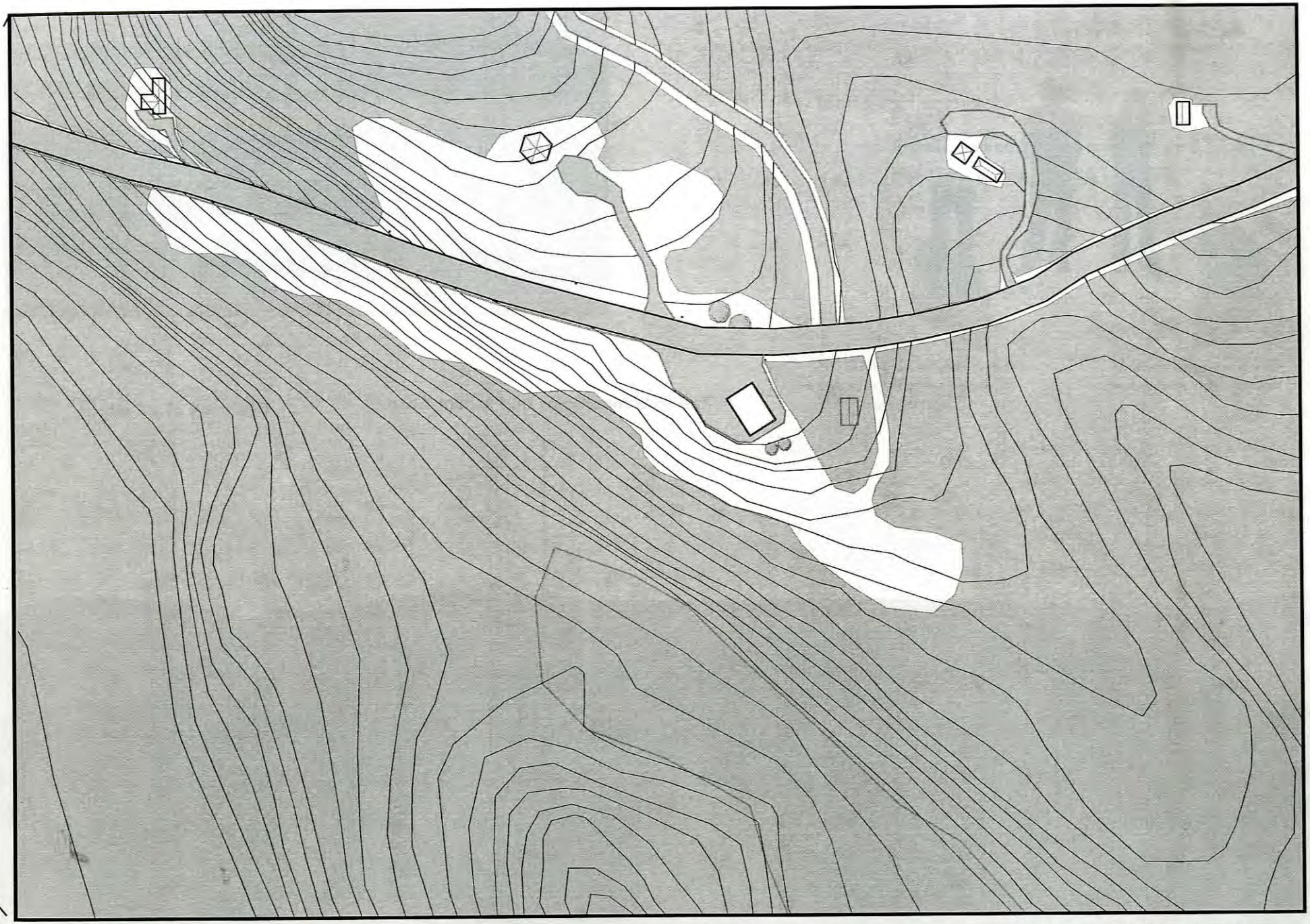
View Entering Town

View Leaving Town



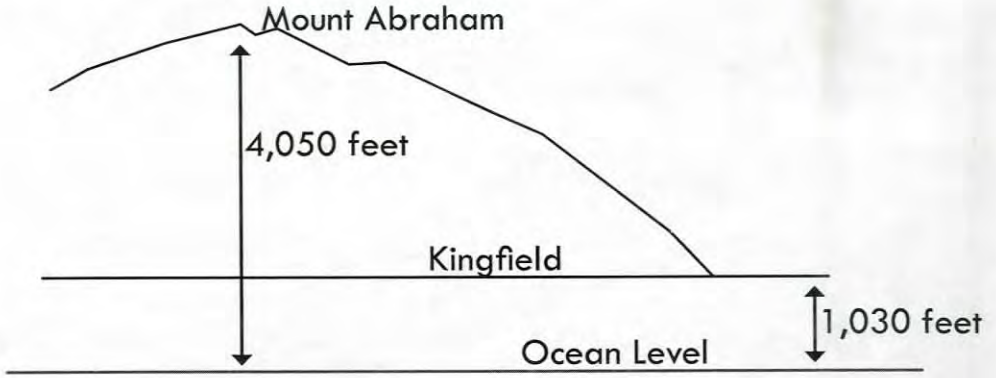
http://terraserver-usa.com/

Site Location



Site Plan

Average Household
Size: 2.43



The Blue Mountains and Mount Abra-

Kingfield

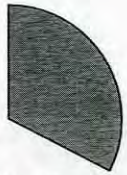
South

Site Section

Site: Kingfield, Maine

44°58' 26" N 70°10' 3"W

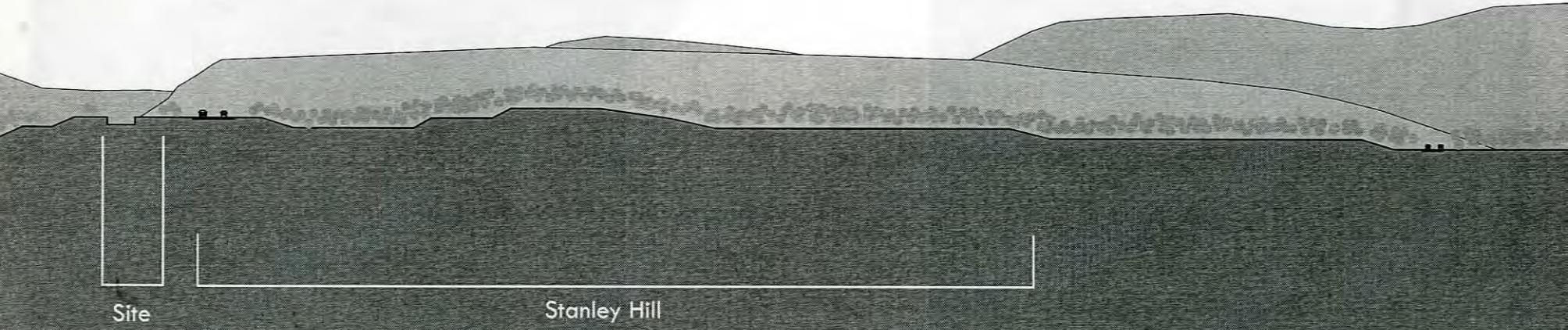
Population: 1,103 people
Median Income for a Family: $37,614
Per Capita Income: $15,954.



32.6% of families have children under the age of 18 living with them

51.5% of people are married couples living together

Route 16 To Kingfield

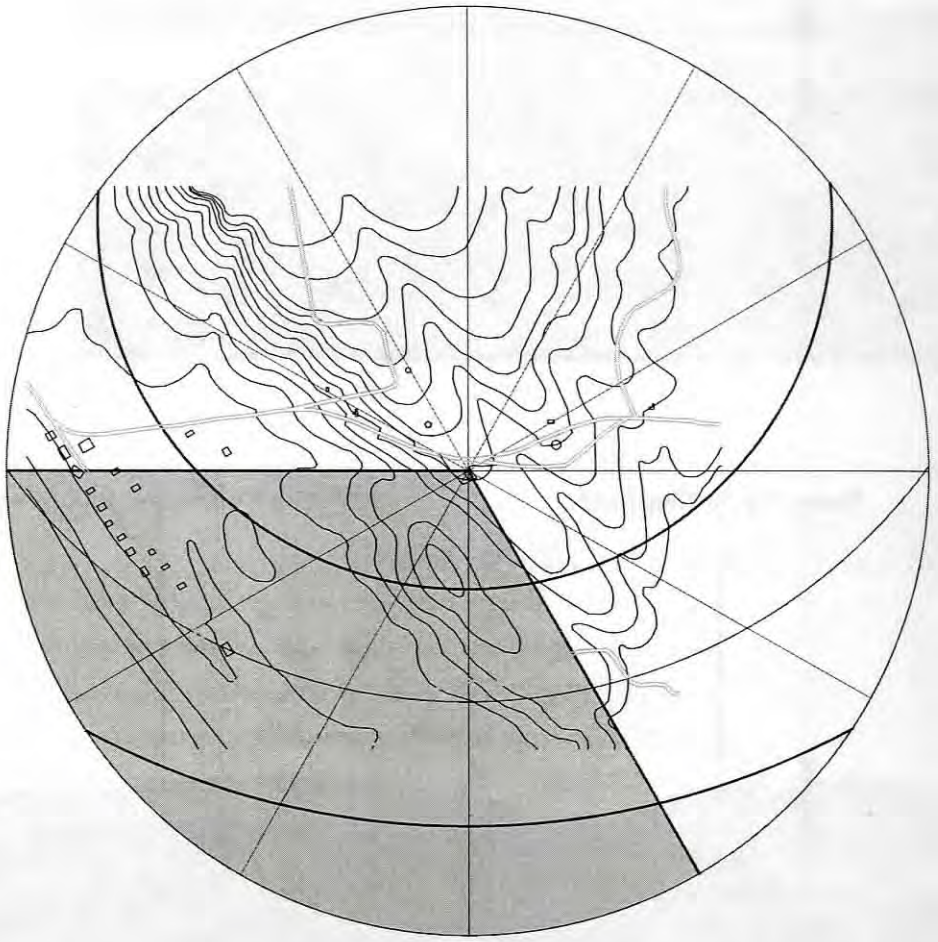


Within a mile from the town center, this site is a perfect location for an environmental education center which focuses on divulging the physical process of a buildings formation. With the Blue Mountains as the backdrop and the town of Kingfield in the foreground the site frames the context perfectly to reveal the connections between the built environment and the natural one.

On the site is an old logging truck shed. In its heyday it had between seven to ten trucks based out of this site. Repairs and storage happened here. As the economy decreased as well as the interest of the owners the shed has become unused and is now for sale.

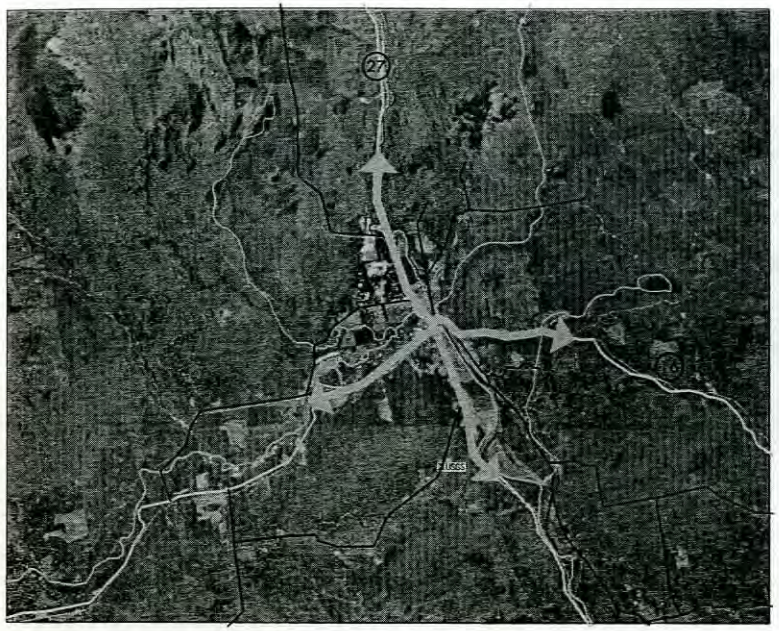
In the last three years logging has been occurring on site to create views of the town, as well make money for the land owner. The site is now a platform looking over Kingfield, a town sitting in a valley amongst ski resorts and natural resources for recreation and economy.

The site is south facing with a panoramic view. This unique location allows for optimal passive heating as well as visibility. When approaching the site from the East one may not even see the existing building as they are so in awe of the mountain view which is framed by an existing pine tree. Where as approaching from town the site is visible for several hundred feet before one arrives.



South facing, the site gets an ample amount of day light. It opens to the west for over a 120 degree mountain view

Movement



Population

Topography

Tree Species Distributed

- Spruce, Fir
- Pine
- Aspen, Birch
- Maple, Beech, Birch

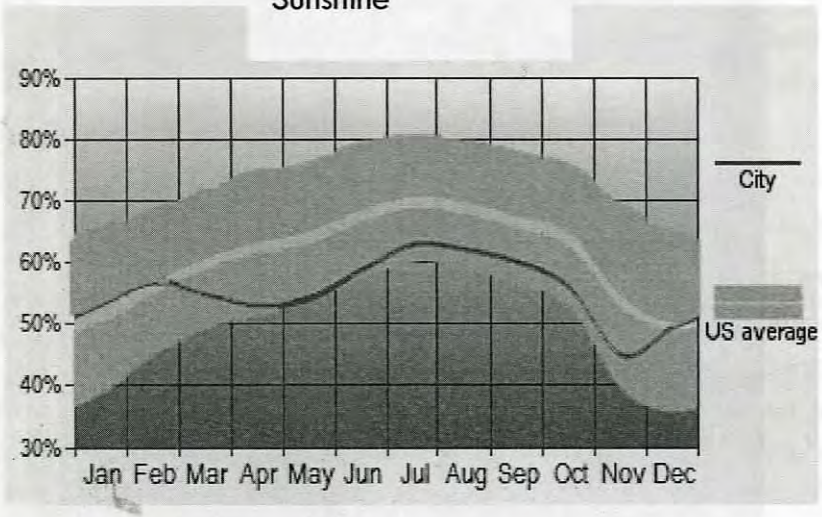
Tree Species

2005

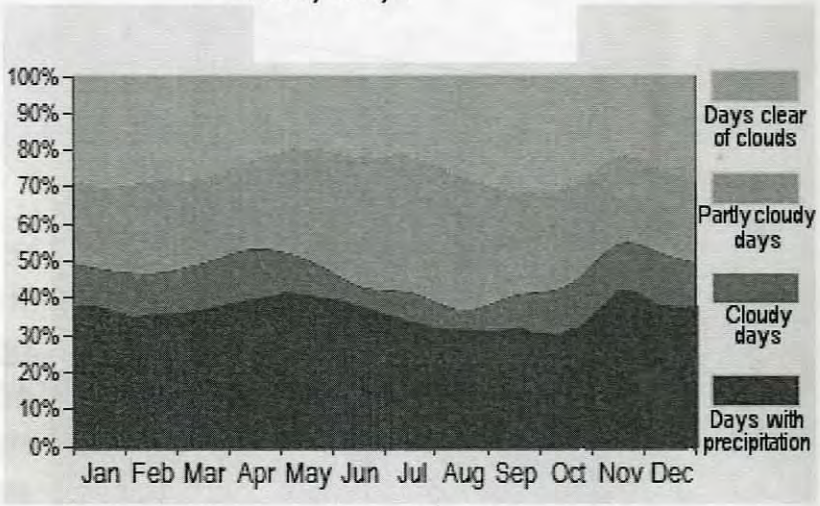
2007

Change in site conditions due to timber harvesting

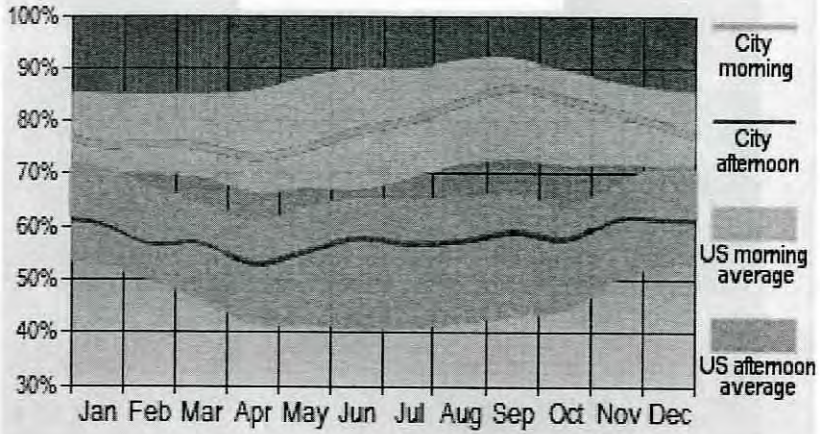
Sunshine



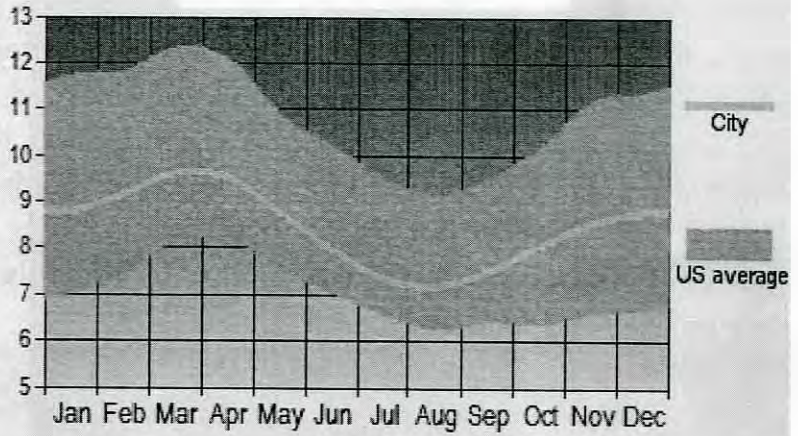
Cloudy Days



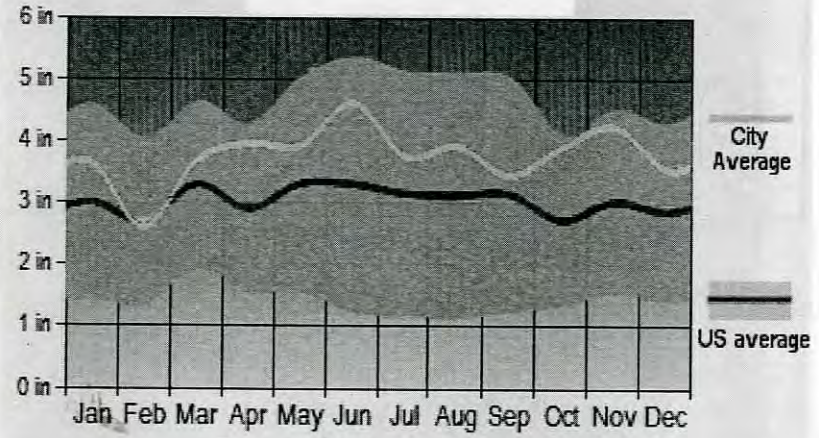
Humidity



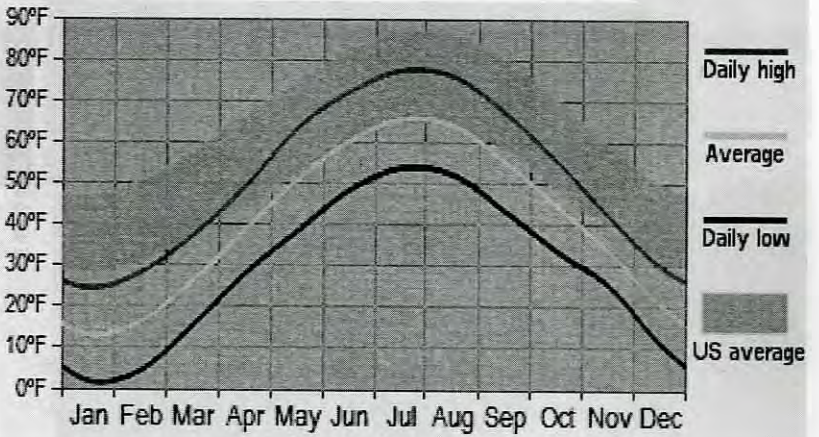
Wind Speed (mph)



Precipitation

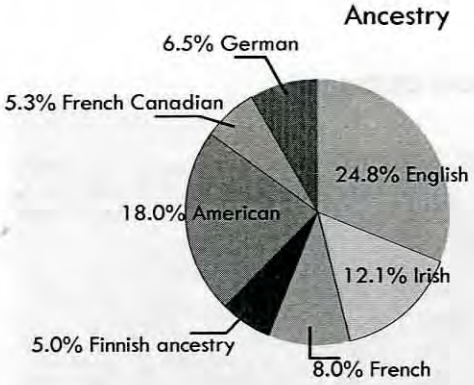


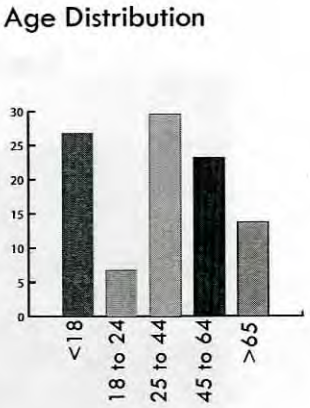
Average Temperatures



When on the site, one can only see Sugarloaf from a particular angle, this along with the nature of the view separates the site into three zones of viewing, where the New Vineyard Mountains and Sugarloaf can only be seen from specific zones, the view of Mount Abraham is visible no matter where one stands.

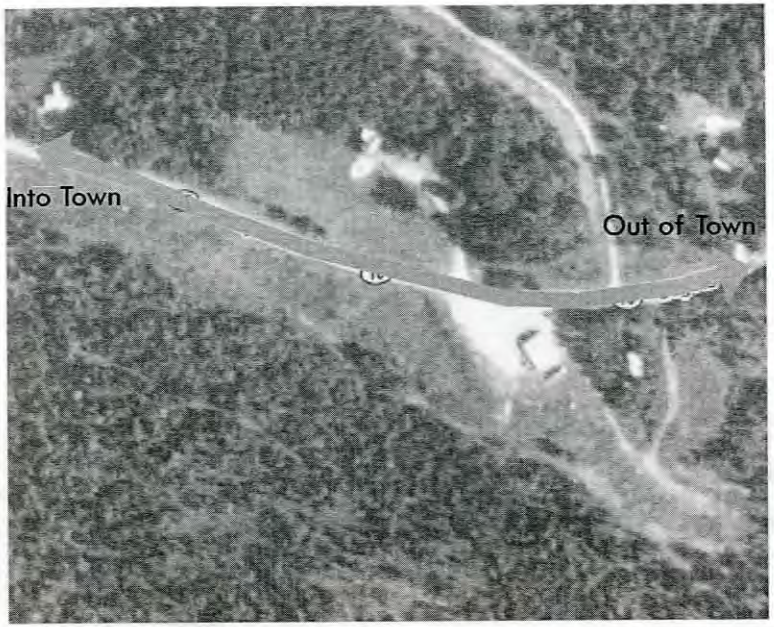
The site is abandoned farm land, producing primarily softwoods, such as Pine, Hemlock and Cedar



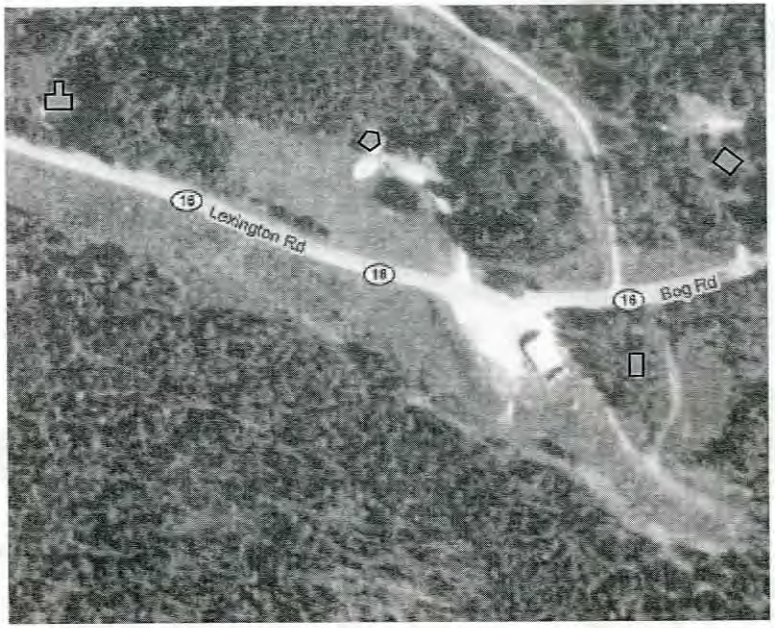


- **Spruce-** Structures, roofing, cladding, laminated timber, fiberboard
- **Pine-** Structures, floors, cladding, windows, doors, tar, roofing, foundations below ground level, plugs
- **Aspen-** Floors, plywood, suspended ceiling, smaller structures, cladding, piping for water and gutters, piles
- **Birch-** Floors, stairs, internal panelling veneer, chipboard, bark for damp proofing, smaller structures
- **Maple-** Floors, balustrades, stairs, plugs
- **Beech-** Floors, balustrades, smaller structures, veneer, internal panelling, tar, vinegar

Movement

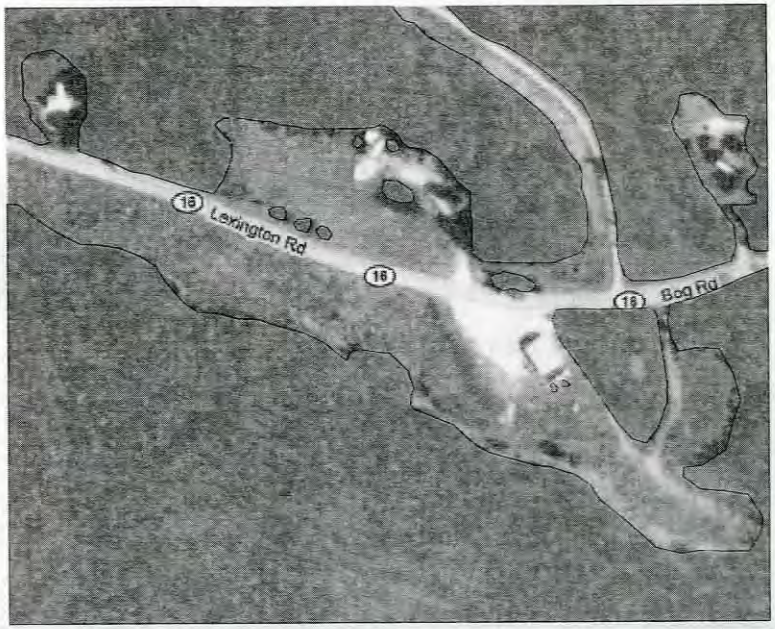


Built Environment

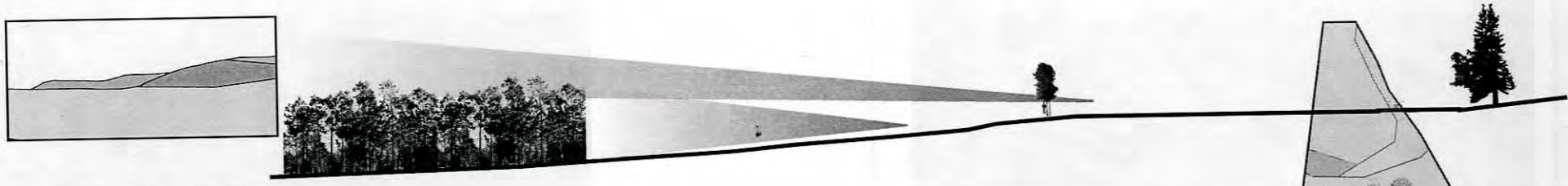


Topography

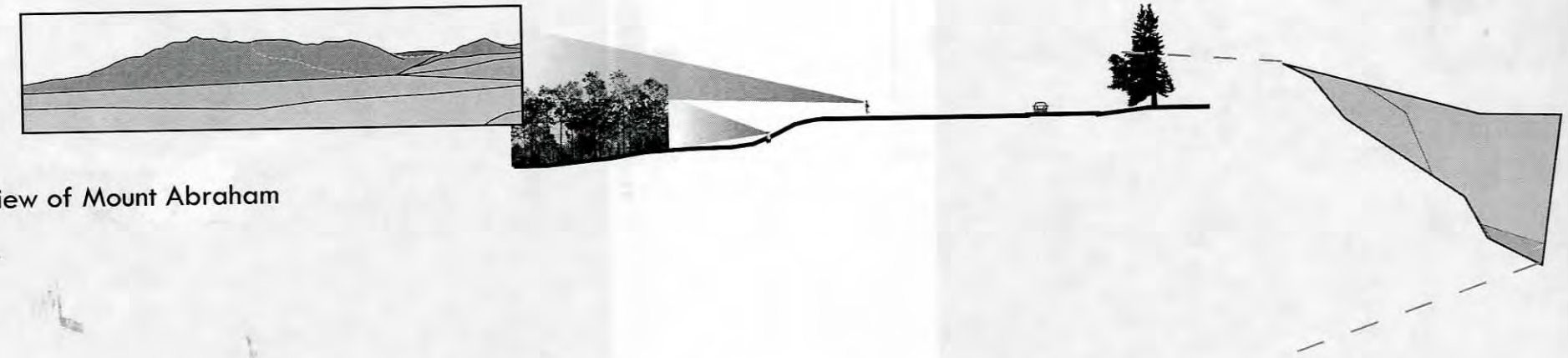
Tree Cover



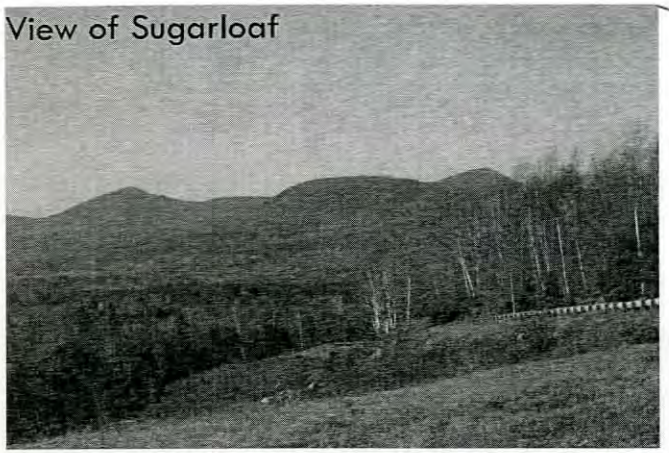
View of Sugarloaf

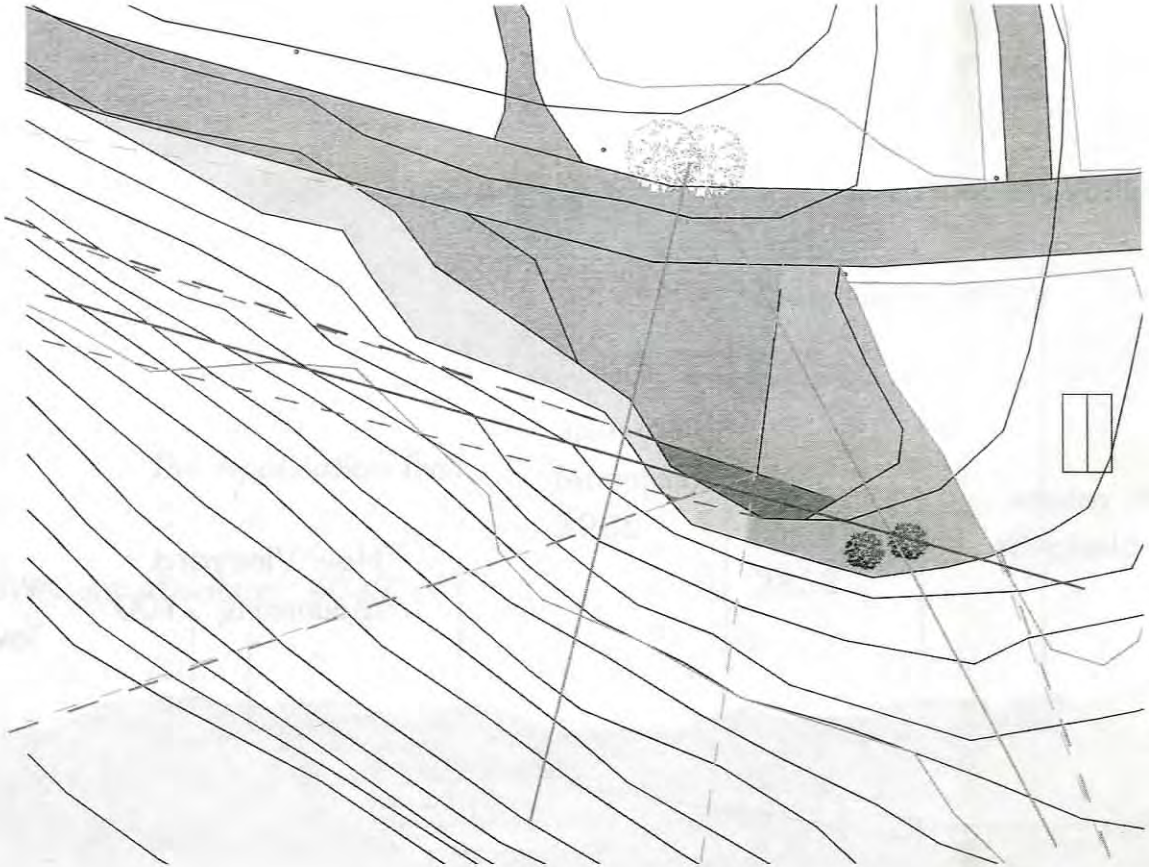


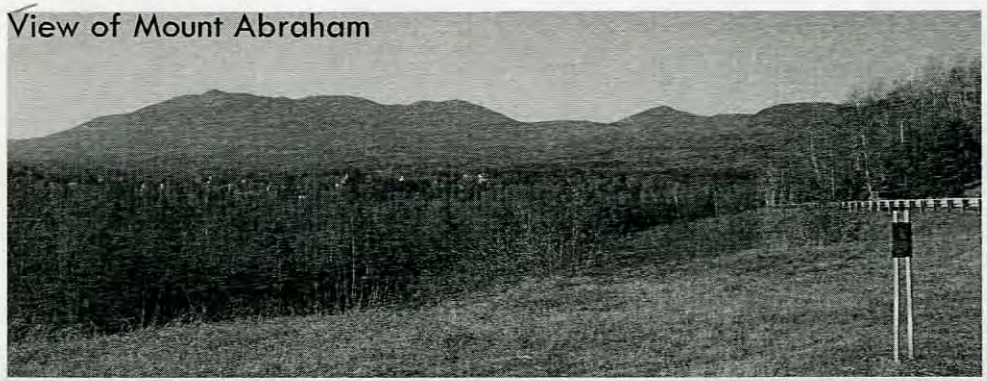
View of New Vineyard Mountains



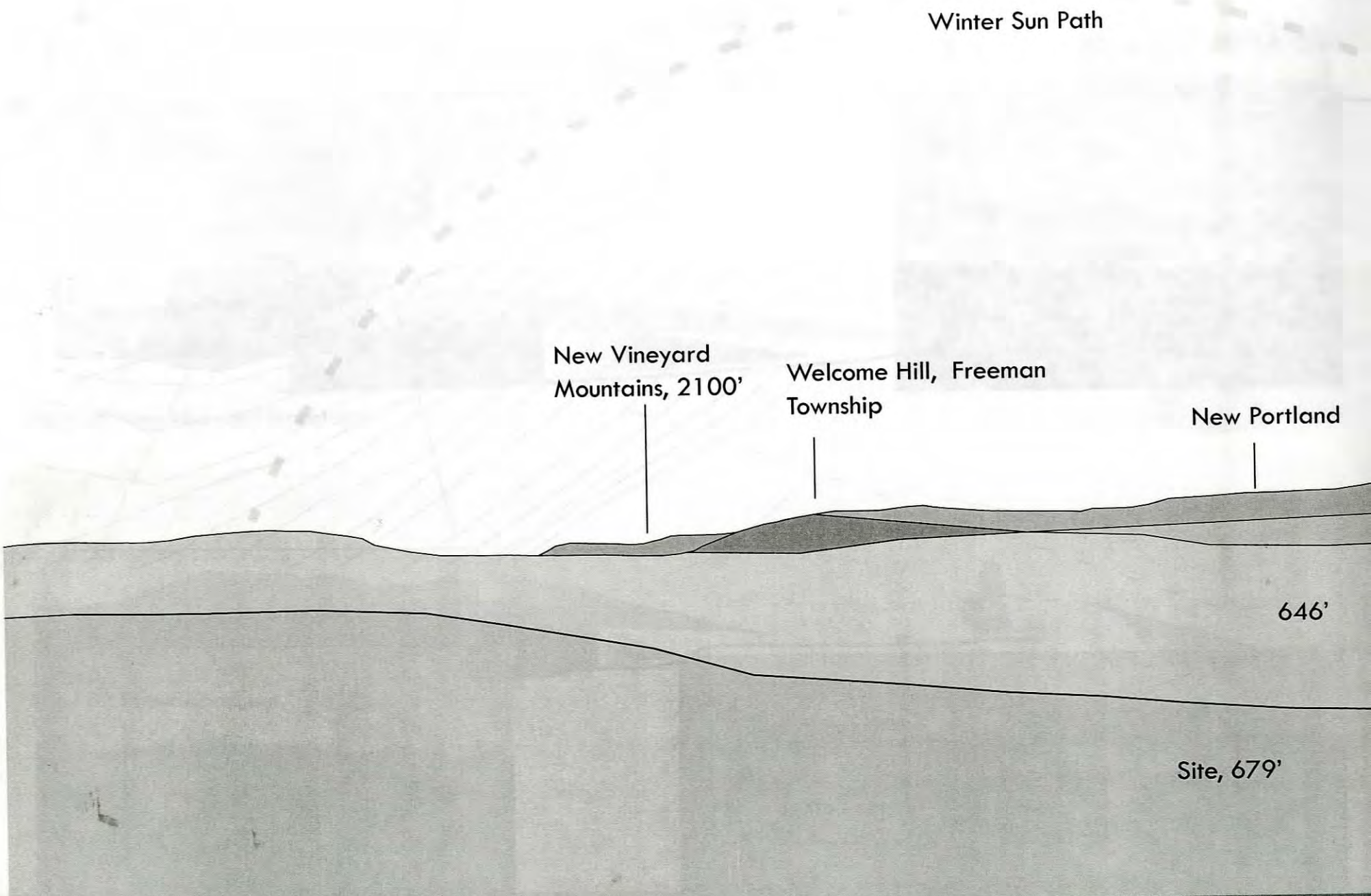
View of Mount Abraham


View of Sugarloaf

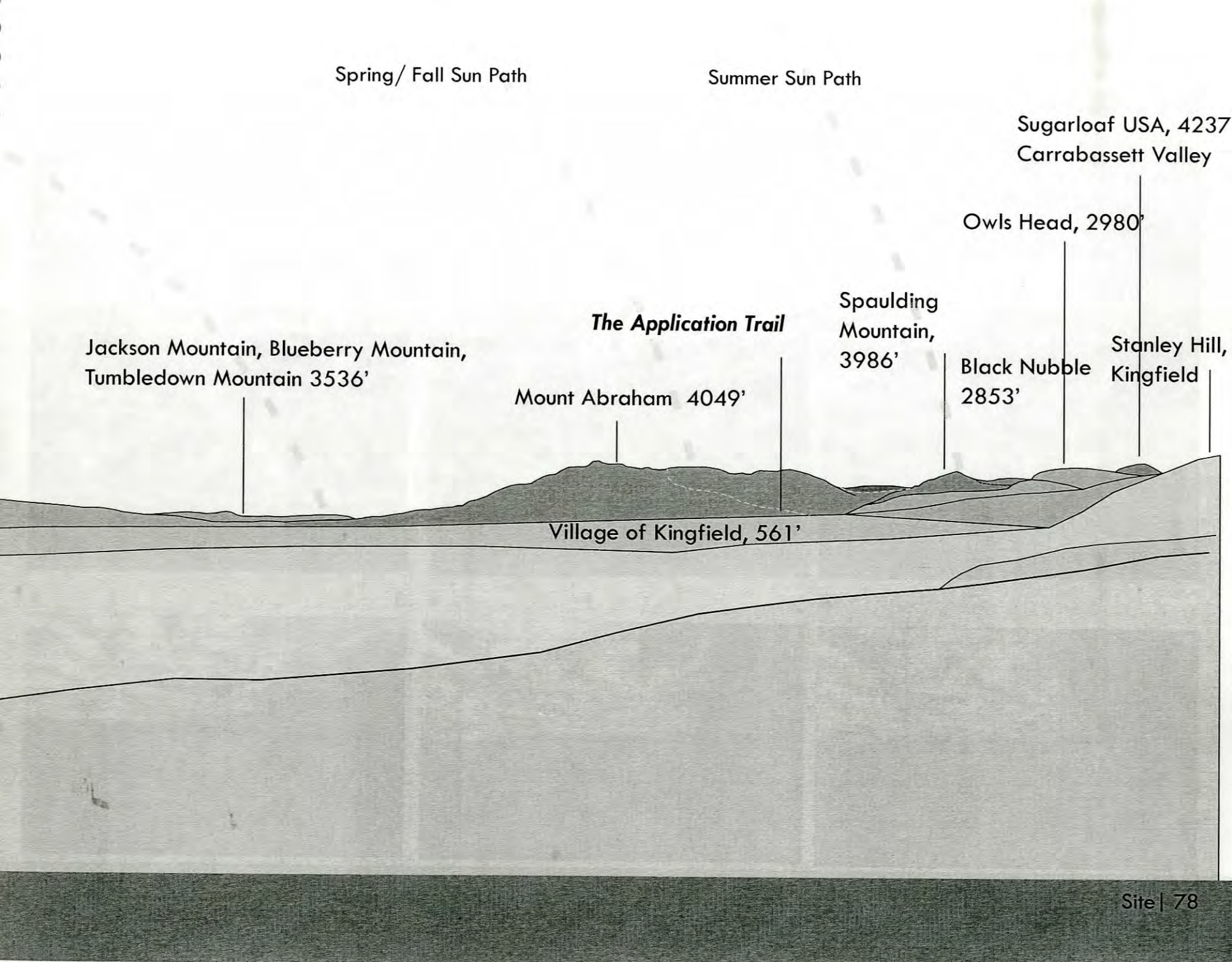


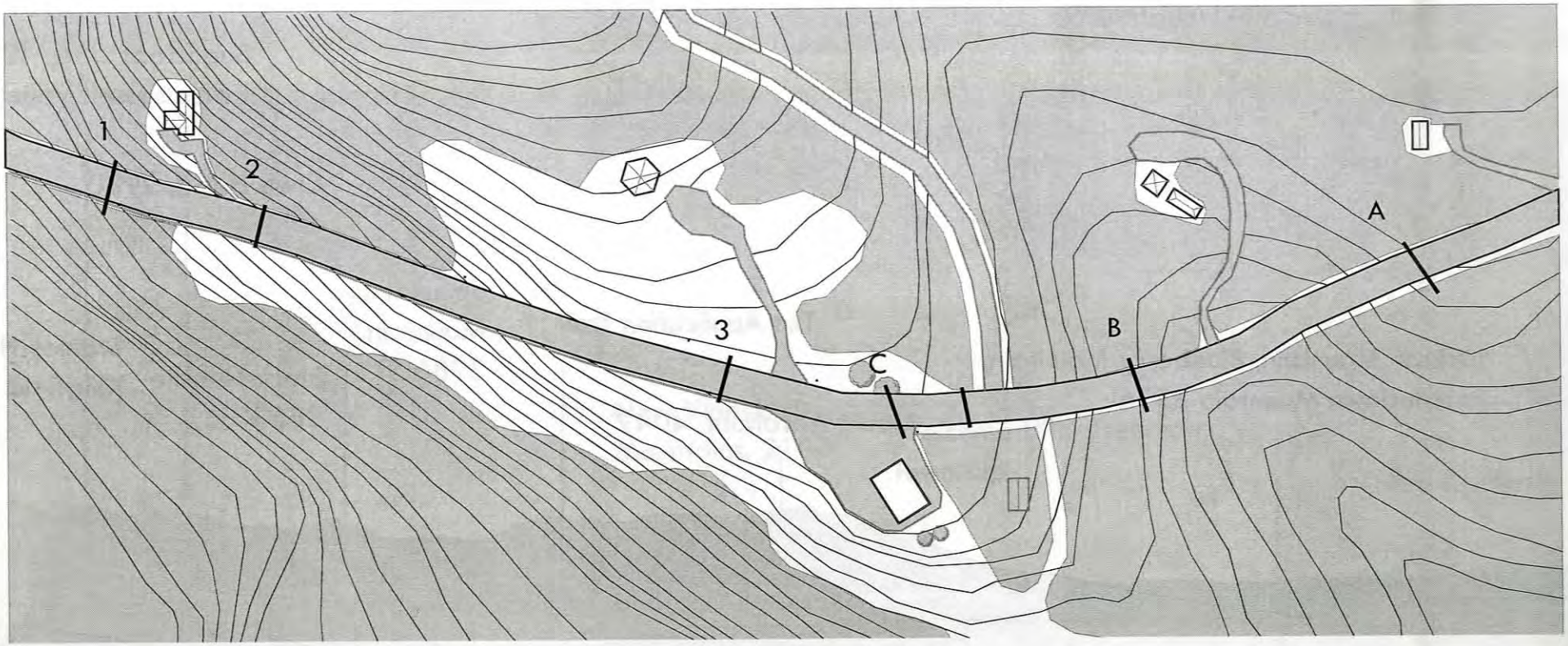

View of Mount Abraham


View of New Vineyard Mountains



Panoramic View


Spring/ Fall Sun Path
Summer Sun Path
Sugarloaf USA, 4237
Carrabassett Valley
Owls Head, 2980'
Spaulding
Mountain,
3986'
The Application Trail
Jackson Mountain, Blueberry Mountain,
Tumbledown Mountain 3536'
Mount Abraham 4049'
Black Nubble
2853'
Stanley Hill,
Kingfield
Village of Kingfield, 561'



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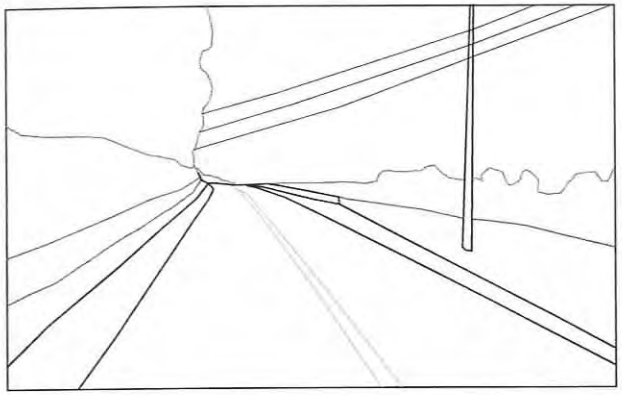
Approach

1



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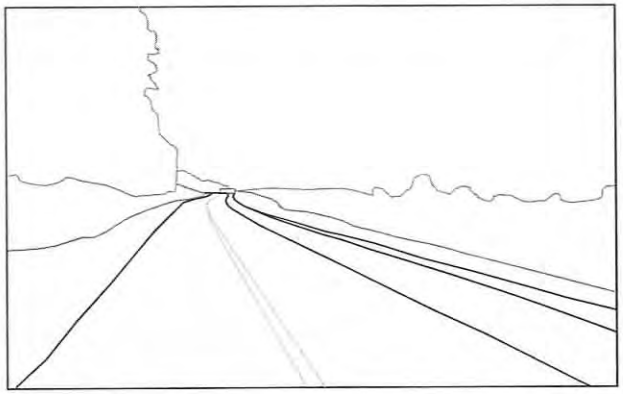

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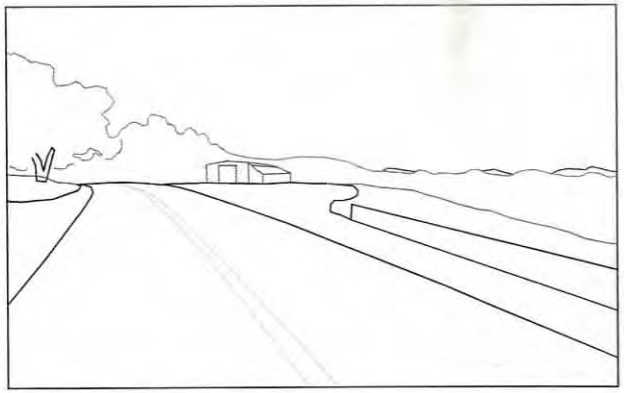

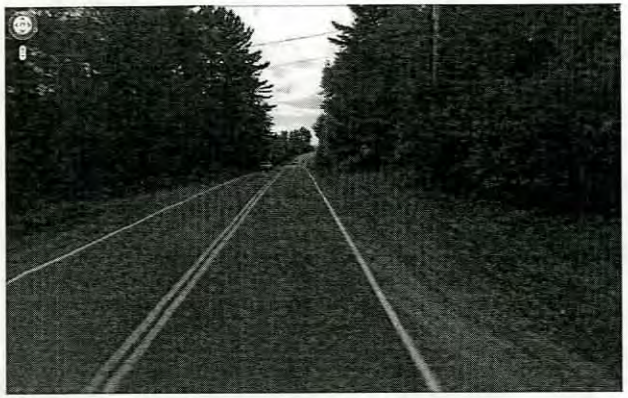

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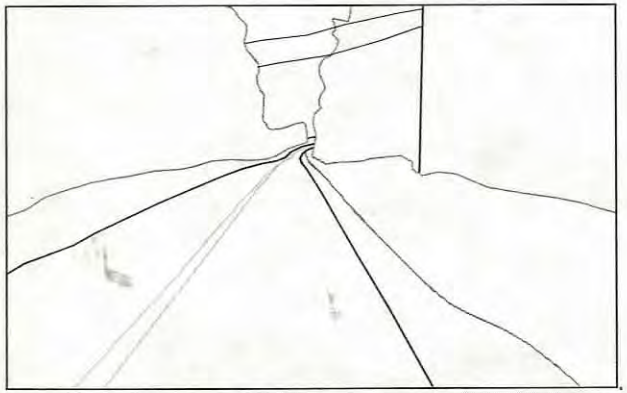

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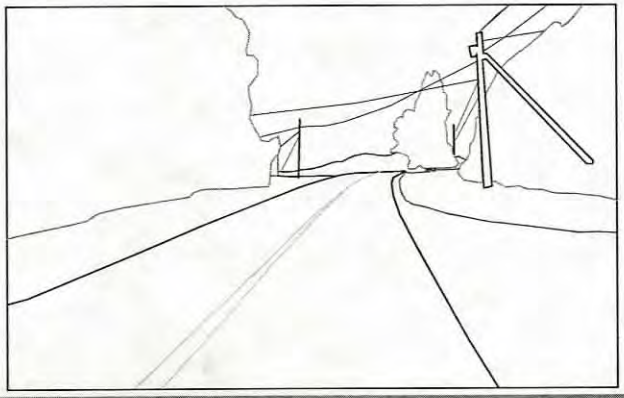
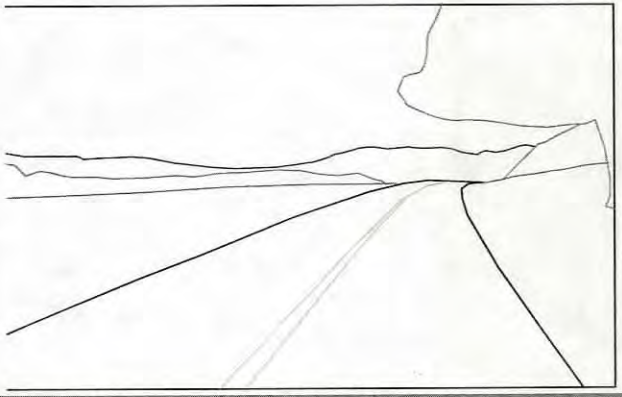


C



Precedent Studies

Precedent Studies

Project	Architect	Location	Sq. Ft.	Site	Type
Educational Facilities					
Discovery Center at South Lake Union	The Miller|Hull Partnership	Seattle, WA	11,000	Urban	Commercial office and Exhibit hall
Hilltop Arboretum	Lake | Flato	Louisiana State University, Baton Rouge	10,000	Rural	Exhibit Areas and Administration Offices
Center for Regenerative Studies	Dougherty + Dougherty	California State Polytechnic University, Pomona	74,100	Rural	Multi-unit residential, Campus, Higher education
Environmental Learning Center at Westcave Preserve	Robert Jackson & Michael McElhaney Architects	Round Mountain, Texas	3,030	Rural	Interpretive Center
Religious Facilities					
Mortensrud church	Jensen & Skodvin Architects	Oslo, Norway	23,540	Rural	Parish Church
Komyo-ji Temple	Tadao Ando	550 Omachi Saijo-shi, Ehime, Japan	5,000	Urban	Buddhist Temple
Homes					
Holzbox	k_m architektur	Lindau, Bravaria, Germany	12,840	Rural	Home
Villa Langbo	Olavi Koponen	Langholmen, Kemio, Finland	1,819	Rural	Summer Home
One-Family House Kern Lochau	Baumschlager Eberle	Lochau, Vorarlberg, Austria	1,109	Suburban	Home
Finnish Sauna	Jaakko Keppo	Finland	500	Rural	Sauna and relaxation room

Scope	Connection with Nature	Didactic Aspects	Wooden	
A single building	Suspended above	Modular, demountable and transportable		
A series of connecting spaces through walkways	Reaching into the environment through connecting pathways	Materials and forms echo the vernacular, proximity to nature	●	
5 2-story buildings	Creates a complete ecosystem, including the building and the people	Demonstrates heavy and light construction types , configuration, orientation, shade, and light	●	
A single Building	Simplifies and teaches ecological processes through design	Interactive, demonstrations through materiality, and design mimicking nature		
One Primary Building in a complex of buildings	Incorporating aspects	Reinforces natural aspects inside and out, creative use of material		
One Primary Building in a complex of buildings	Through use of light and material	Repetitive layering and connections	●	
A single building	Framing Views	Enforces particular view points	●	
A single building	Encompassing nature	Transparent, separates the layers of container, umbrella and nature	●	
A single building	Use of light	Repetitive, articulated	●	
A single building	Incoporating, framing and a small footprint	Regularized grid, simplified construction	●	

Discovery Center at South Lake Union	The Miller | Hull Partnership	Seattle, WA	11,000	Urban	Commercial office and Exhibit hall

415 visitors per week	1 hour per week
10 employees	40 hours a week

Program

- Conference rooms
- Offices
- Exhibit hall
- Restrooms

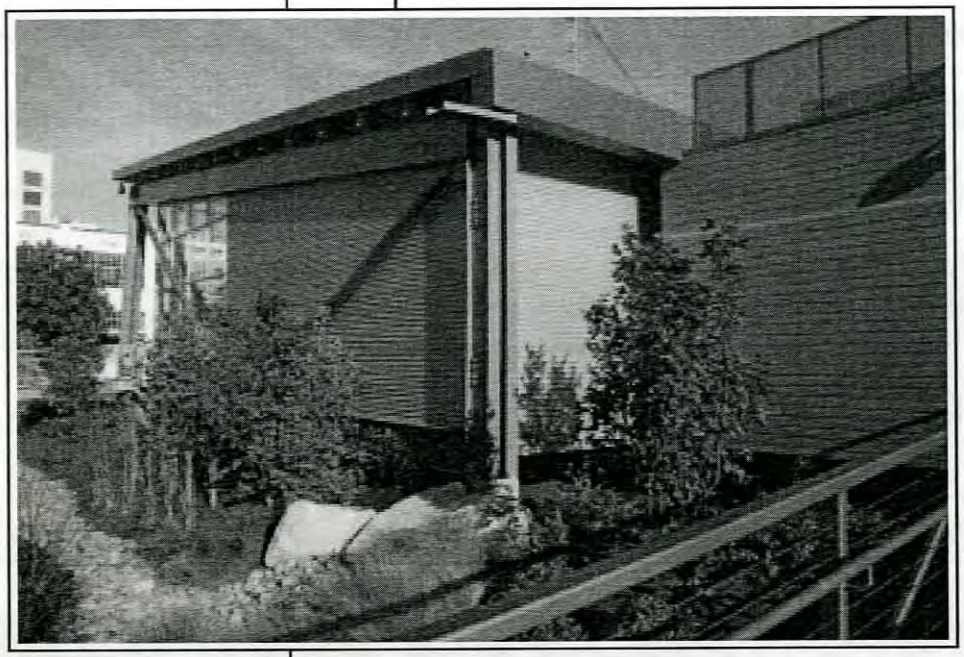
Strategies

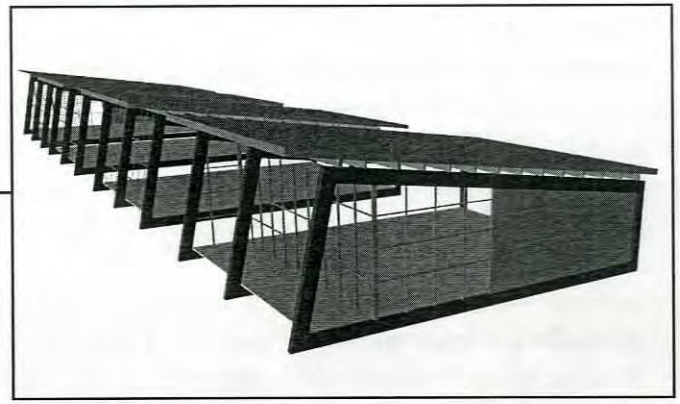
- Use large exterior windows and high ceilings to increase day lighting
- Design open floor plans to allow exterior daylight to penetrate to the interior
- Plan for Materials Longevity
- Use materials and systems with low maintenance requirements

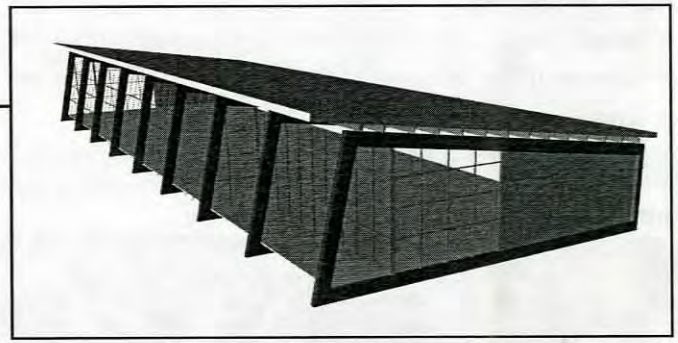
A single building

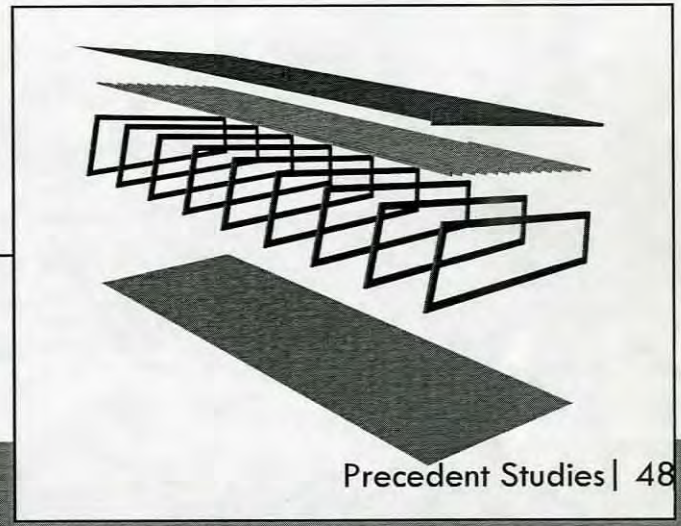
Suspended above

Modular, demountable and transportable







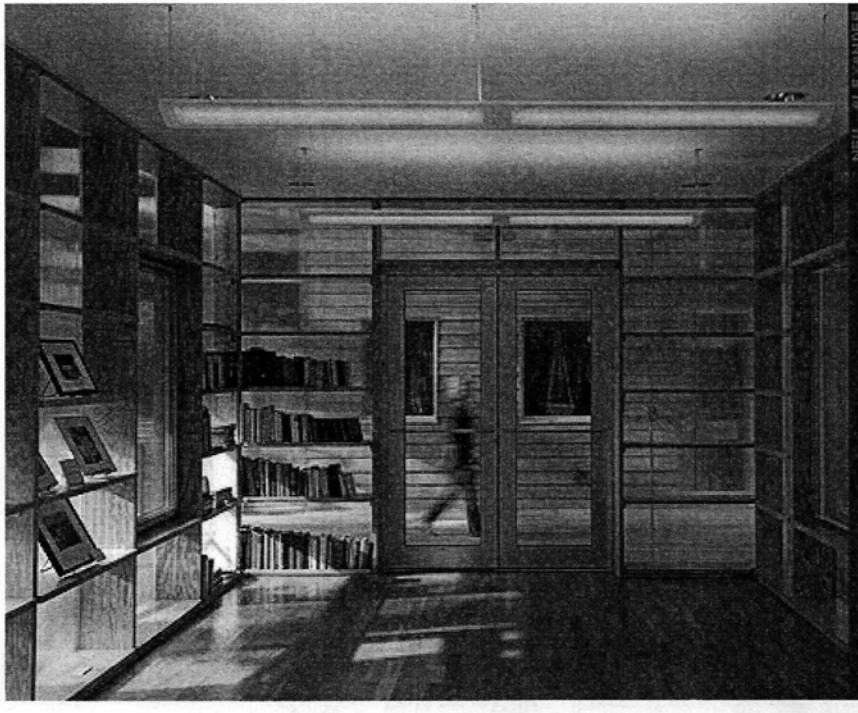


Hilltop Arboretum	Lake | Flato	Louisiana State University, Baton Rouge	10,000	Rural	Exhibit Areas and Administration Offices

Program/ Programs

- **Symposium** An *annual event* featuring lectures by nationally-recognized experts in horticulture, landscape architecture, and sustainable design accompanied by a plant sale.
- **Sustainable Landscape Series:** An adult education program focused on sustainable landscape design, gardening and tree care that includes a hands-on activity using the arboretum grounds for practical experience.
- **Landscape Architecture Day** An event for high school students to explore the process of seeing and creating landscapes using the Arboretum as a design laboratory.
- **Summer Academy***: summer day camp* opportunities for children held on site at Hilltop that teach about nature up close in a fun environment.
- **Arbor Day Programs** which focus on proper tree care and maintenance techniques
- **Teacher Workshops** to demonstrate to teachers and other interested community agencies how to effectively use Hilltop as an extension of the traditional classroom
- **Scout Projects** Earn a landscape architecture badge at Hilltop.
- **Community Outreach** to community organizations and agencies having similar missions
- **Speakers Bureau**
- **Tours:** Docent guided or self-guided, for school groups, clubs, handicapped, seniors, scouts.

http://www.lakeflato.com/projects/lsu



A series of connecting spaces through walkways

Reaching into the environment through connecting pathways

Materials and forms echo the vernacular, proximity to nature

Exhibit areas
Meeting space
Gift shop
Administration offices
Storage
Circulation space

Basic Construction Materials:

Foundations: Concrete drilled shafts

Primary Floor Framing: Glue laminated wood beams and girders attached with galvanized steel brackets.

Roof Support Columns: Pressure treated wood piles, galvanized "X" bracing with turnbuckles.

Roof Structure: Pre-assembled roof trusses fabricated from dimensional lumber.

Roofing: Corrugated aluminized steel and translucent polycarbonate panels.

Gutters and Downspouts: Galvanized iron.

Exterior Siding and Trim: Tidewater Cypress with galvanized iron sheets at special locations.

Exterior Decking: Pressure treated wood over pressure treated wood joists.

Plastic Wall Panels: 3/8" thick polycarbonate honeycomb sheets.

Guard Rails: Stainless steel marine cables between galvanized steel posts.

Built-ins: Custom built cabinets made from MDF (medium density fiberboard).

Aluminum Windows: A combination of projecting and sliding aluminum windows, glazing nominally 1" thick, clear insulating glass.

Center for Regenerative Studies	Dougherty + Dougherty	California State Polytechnic University, Pomona	74,100	Rural	Multi-unit residential, Campus, Higher education

Typically occupied by 24 people, 168 hours per person per week

Program

Indoor Spaces:

Living quarters, Dining, Restrooms, Classroom, Conference, Office

Outdoor Spaces:

Garden—productive, Drives/roadway, Parking, Patio/hardscape, Shade structures/outdoor rooms, Interpretive landscape, Garden—decorative, Pedestrian/non-motorized vehicle path, Restored landscape

5 2-story buildings

Creates a complete ecosystem, including the building and the people

Demonstrates heavy and light construction types , configuration, orientation, shade, and light

Strategies

- Long-lasting, low-maintenance, f materials;
- Reusable, recyclable, and/or made of recyclable components;
- Minimum impact on nonrenewable resources;
- Maximum passive solar properties;
- Nontoxic in production, use, reuse, and disposal;
- By-products of other manufacturing processes;
- Not based on petrochemicals, except for waterproofing; and
- From industries that have exhibited a commitment to renewable resources and a corporate commitment to environmental issues.

A 6" width was specified for exterior cladding and decking because it results in the least waste in milling. All cedar was dipped in a nontoxic sealer to extend the wood's useful life.

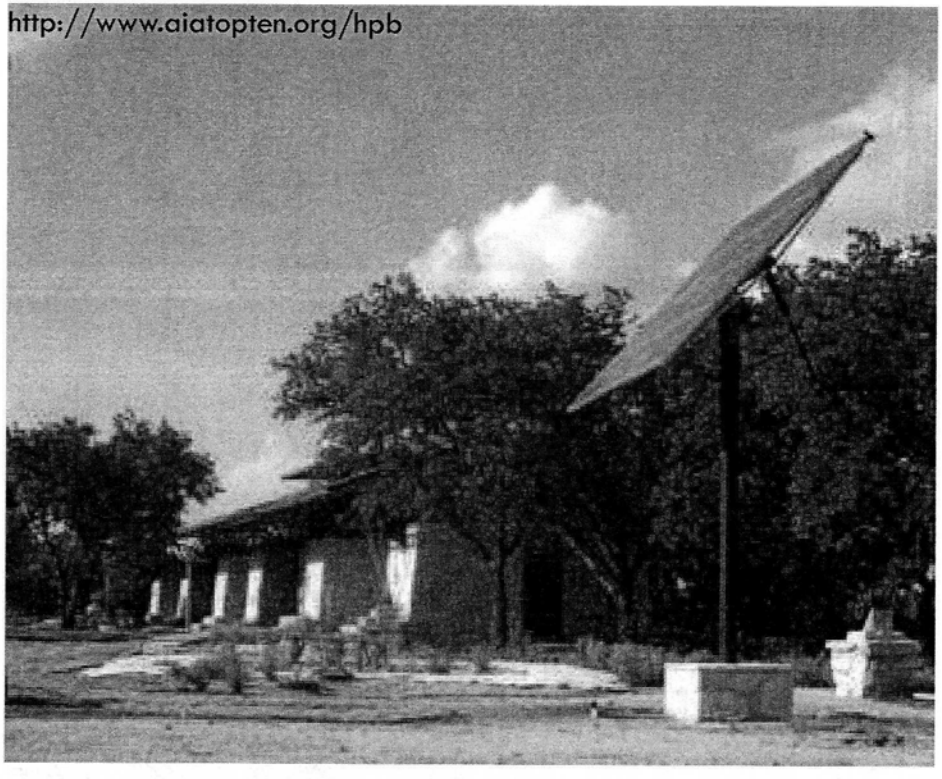
- Use siting and topography to enhance summer breezes
- Use operable windows
- Use ceiling fans to improve comfort at higher temperatures
- Reduce internal heat gains by improving lighting and appliance efficiency
- Use solar water heaters
- Use active solar heating
- Use high-efficiency clothes washers

Environmental Learning Center at Westcave	Robert Jackson & Michael McElhaney Architects	Round Mountain, Texas	3,030	Rural	Interpretive Center

The building's location serves as a gateway to monitor access to the protected preserve trail.

Parking includes:

50 spaces near the building and another 50 approximately 300 feet away. A bus loop and drop-off area serve as a convenient access point for children and elderly and handicapped visitors.

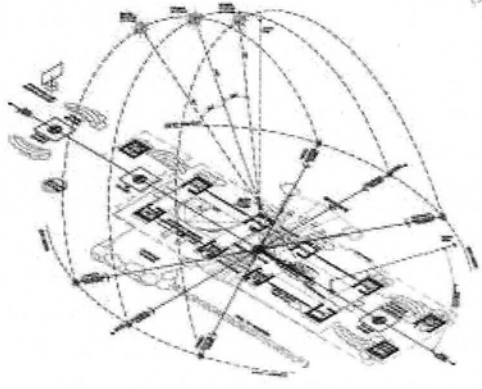


A "wilderness classroom"

Meeting groups include:
Sustainable builders
Architects
Natural science groups
Park and recreational groups
Miscellaneous conservation groups

Visitor's

5,000 to 7,000 student visits each year.
2,000 to 3,000 weekend visitors tour the preserve each year,
500 to 1,000 neighbors as a community center each year;



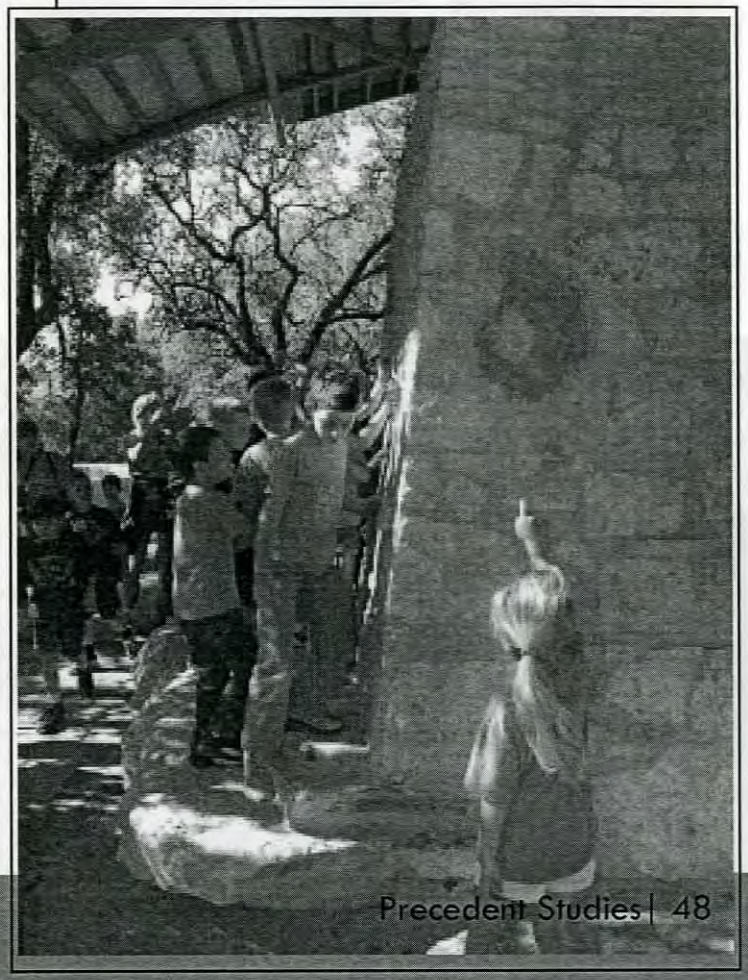
A single Building

Simplifies and teaches ecological processes through design

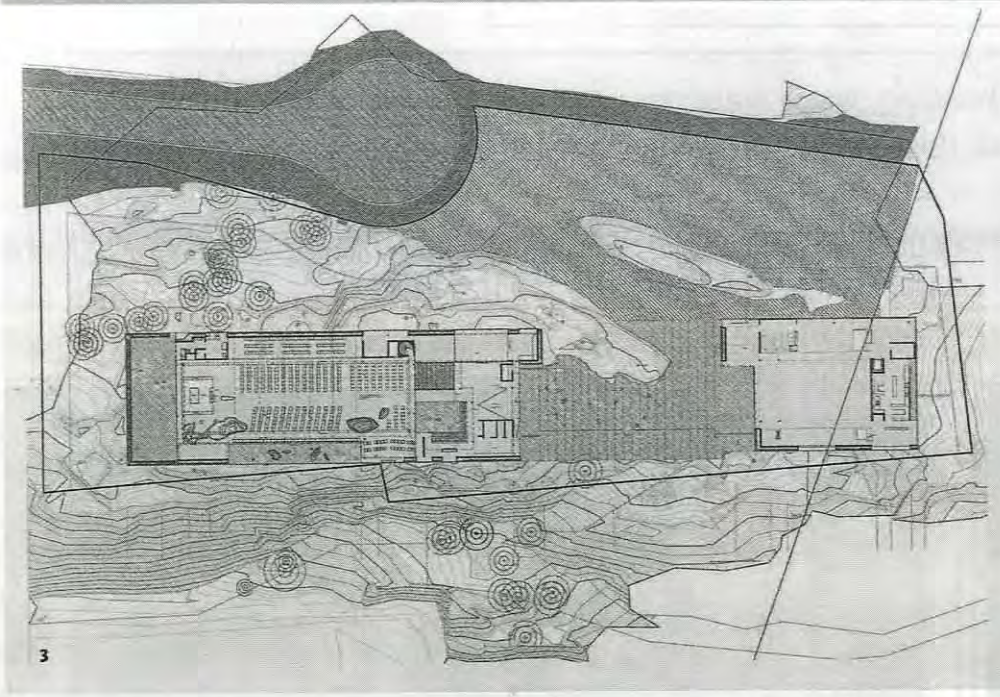
Interactive, demonstrations through materiality, and design mimicking nature

Many exhibits are integrated into the physical structure of the building, which frees the space for maximum flexibility of use. Schoolchildren in groups of 150 to 175 might sit on the terrazzo floor in the "classroom" area in the morning, and a community group might meet in the afternoon around tables to plan the year-end strategy. A third group of visitors might view exhibits in the space, while a fourth informally meets under the large roof canopy with canyon wrens and the sound of the river rapids below.

- Determine whether varying functions can be accommodated in shared spaces
- Minimize space devoted exclusively to circulation
- Use materials and systems with low maintenance requirements



Mortensrud Church	Jensen & Skodvin Architects	Oslo, Norway	23,540	Rural	Parish Church



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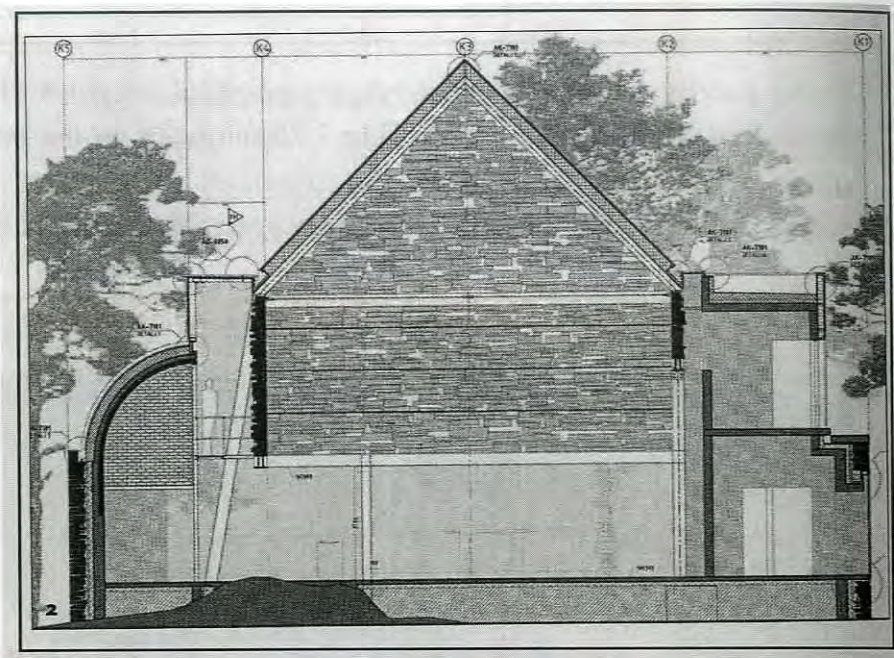


2

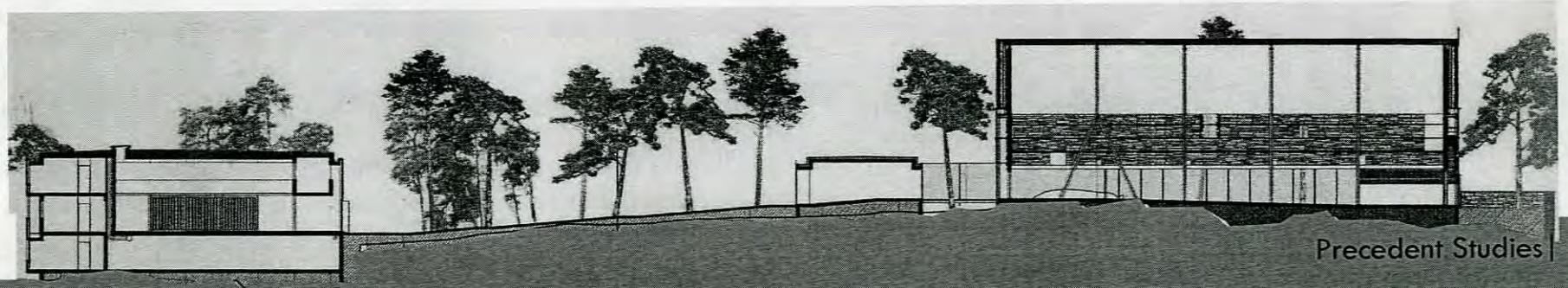
One Primary Building in a complex of buildings

Incorporating aspects

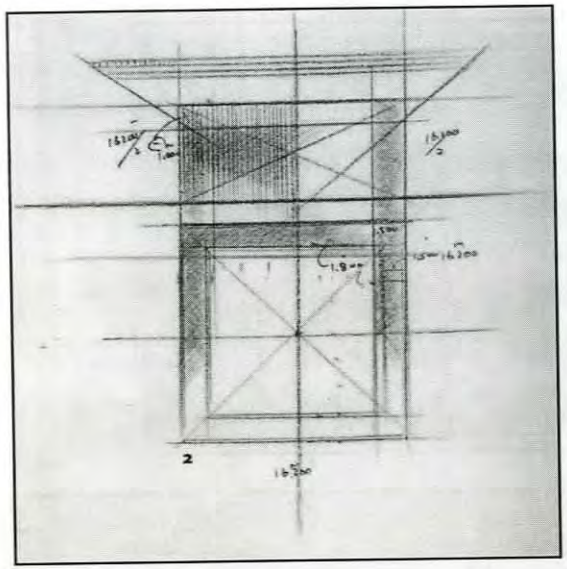
Reinforces natural aspects inside and out, creative use of material

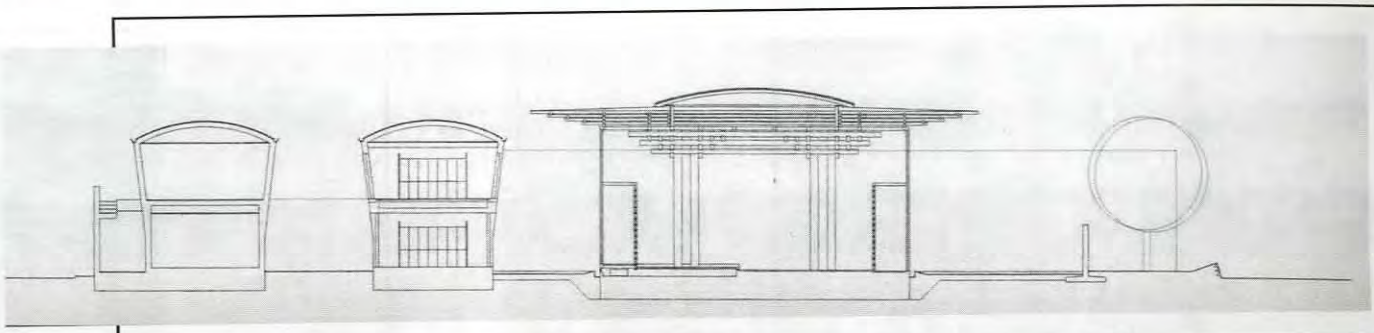
Strategies

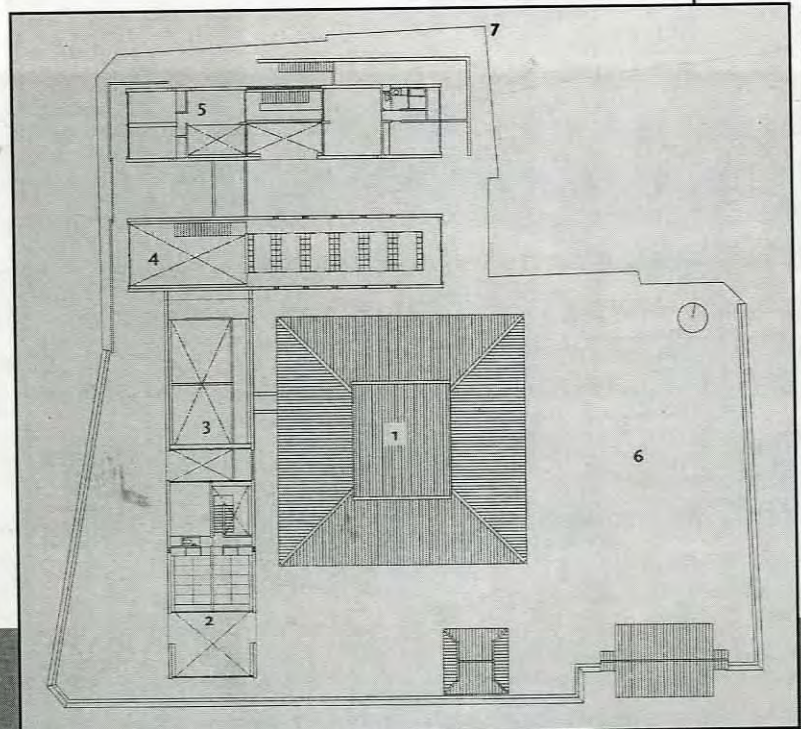
- A visual connection to the outside from the church
- Interact with its site
- Preserve the existing vegetation and topography,
- A number of trees are preserved in atriums within the en-closure.
- Some of the rock formations emerge like islands in the
- No module has been used to determine the exact positions of the gardens.
- The stone in this wall is built without mortar, thus letting light through
- Uses very basic methods and techniques and unique ways

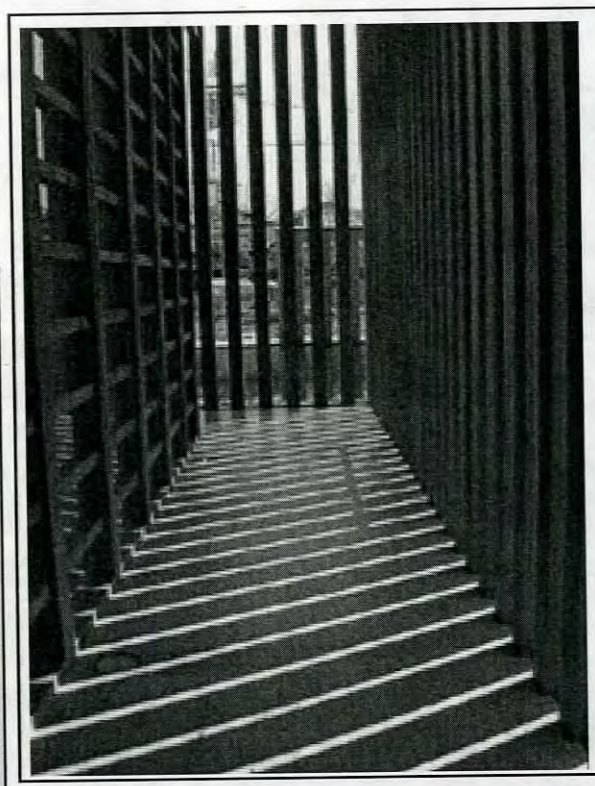


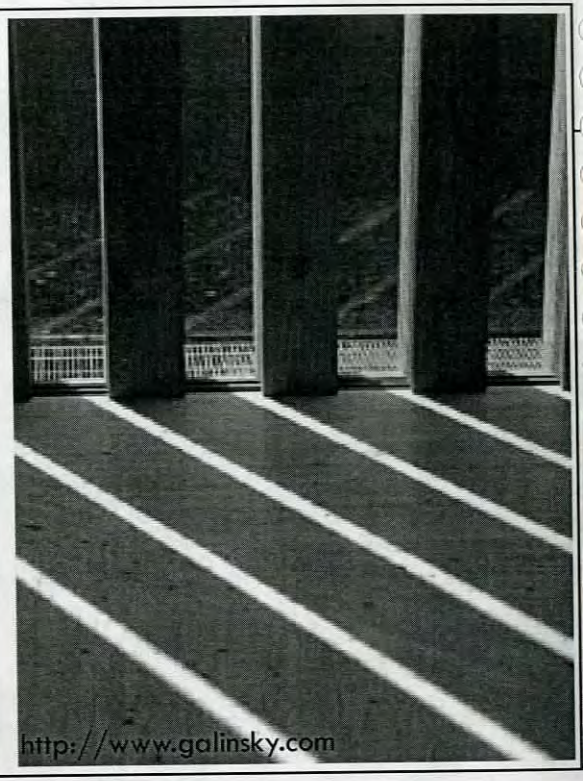
Komyo-ji Temple	Tadao Ando	550 Omachi Saijo-shi, Ehime, Japan	5,000	Urban	Buddhist Temple









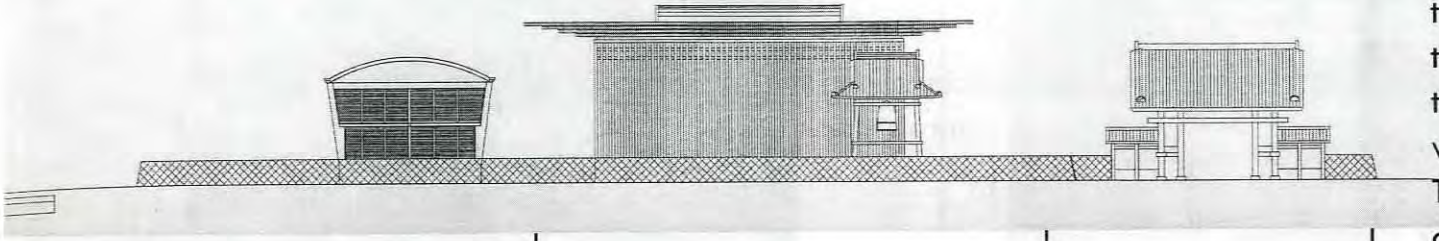


The complex also contains adjacent buildings for community meetings, offices and housing for the monks. These surrounding volumes are constructed in concrete. To enter the temple one traverses a wooden plank over the natural spring water that surrounds the temple.

One Primary Building in a complex of buildings

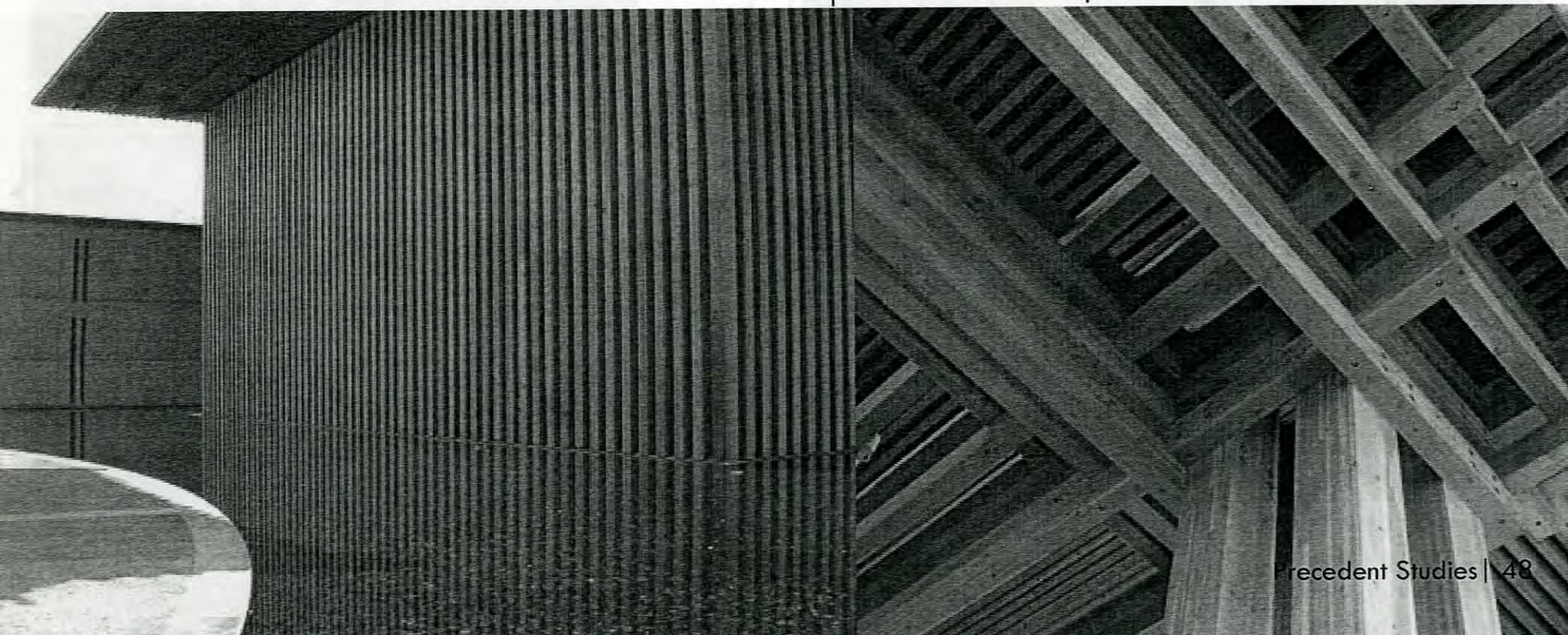
Through use of light and material

Repetitive layering and connections

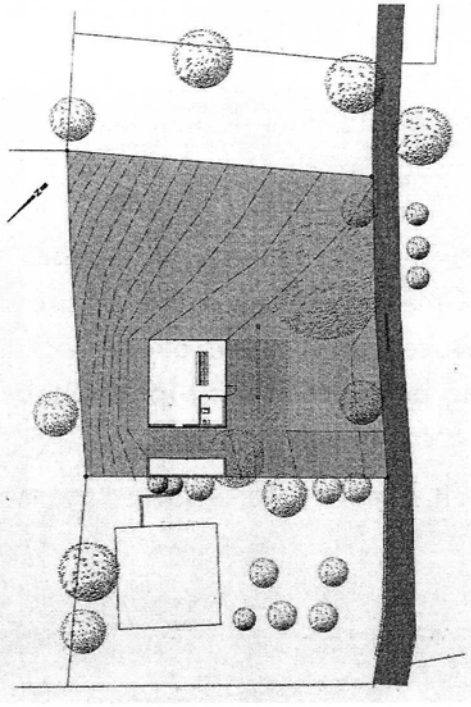


Remnants of the old temple, it replaced are seen throughout the temple site, such as the bell tower and stone foundation walls, through which one winds one's way to the temple

The interior of the sacred space of the temple is a large square space with 3 layers of interlocking beams that are supported by 16 columns in 4 groups.

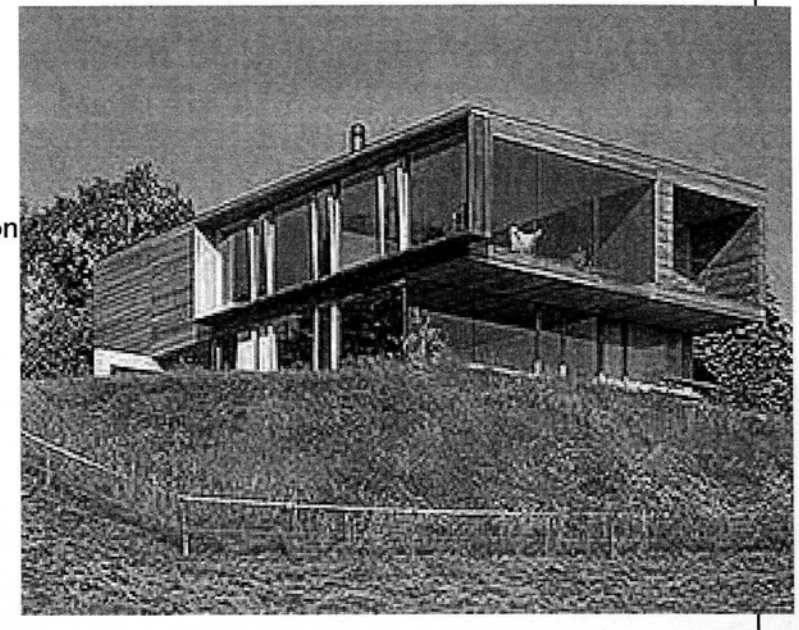


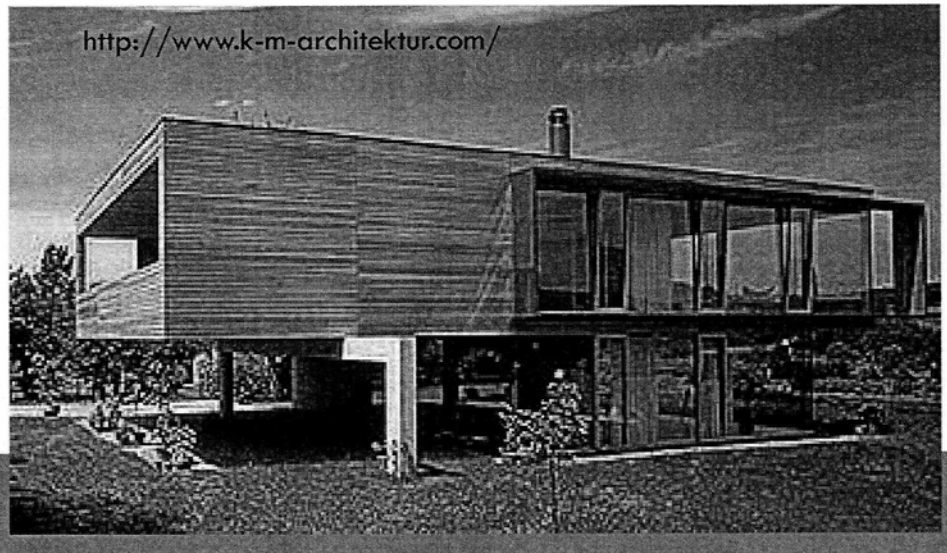
Holzbox	k_m architektur	Lindau, Bravaria, Germany	12,840	Rural	Home

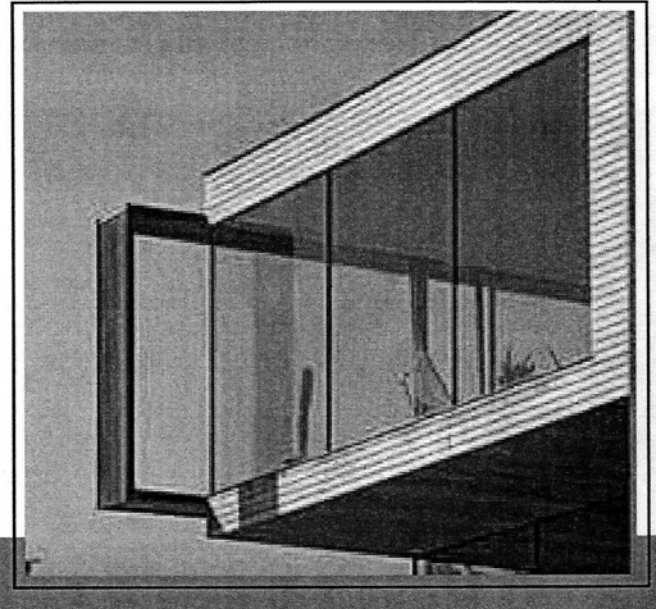


Strategies

- Cantilevered second floor forces views
- Extended horizontal frame controls vision
- Open plan
- Floor to ceiling glass



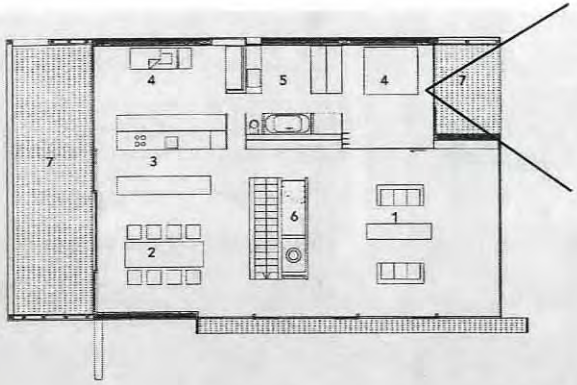


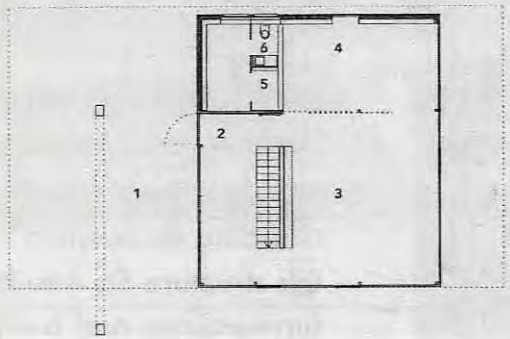


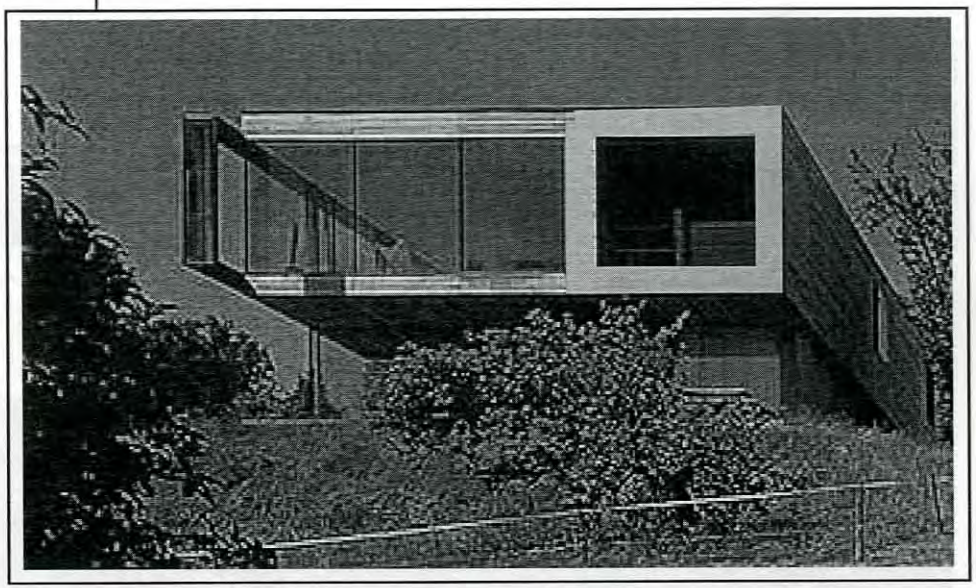
A single building

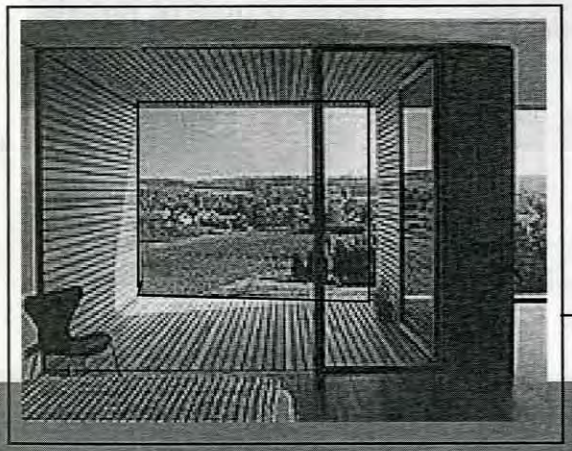
Framing Views

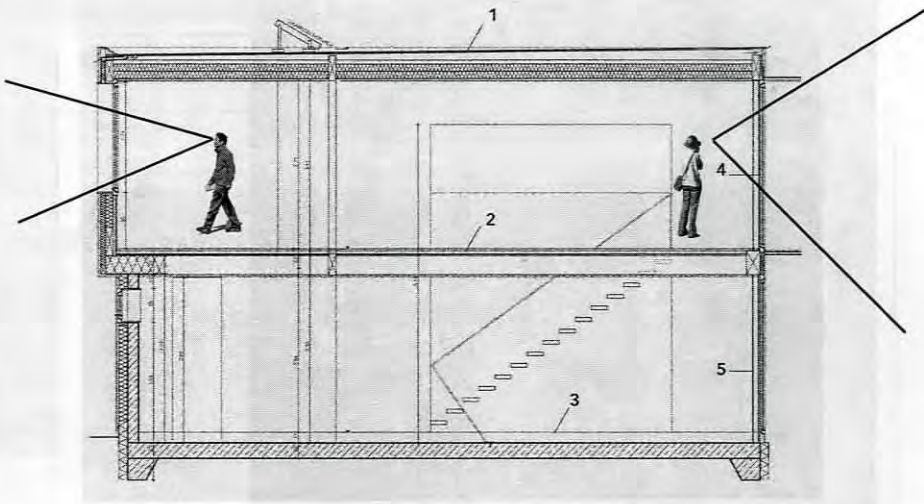
Enforces particular view points



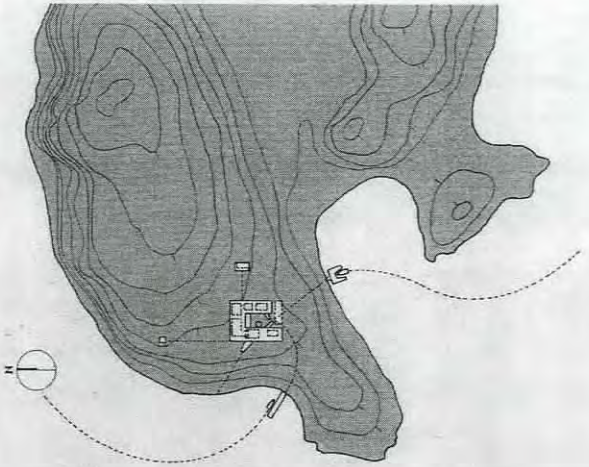


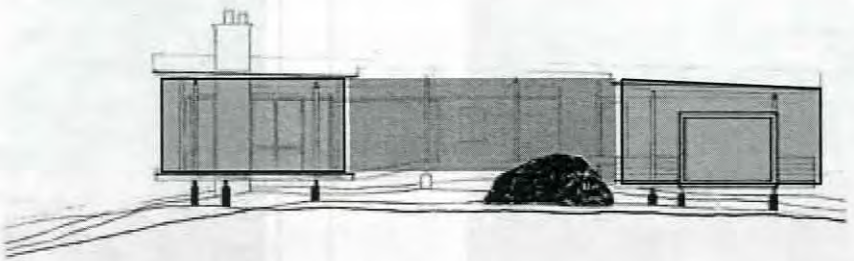


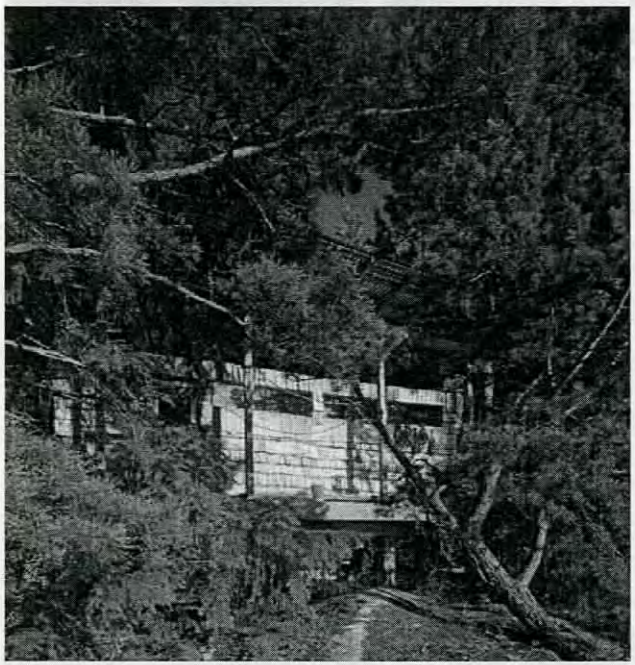


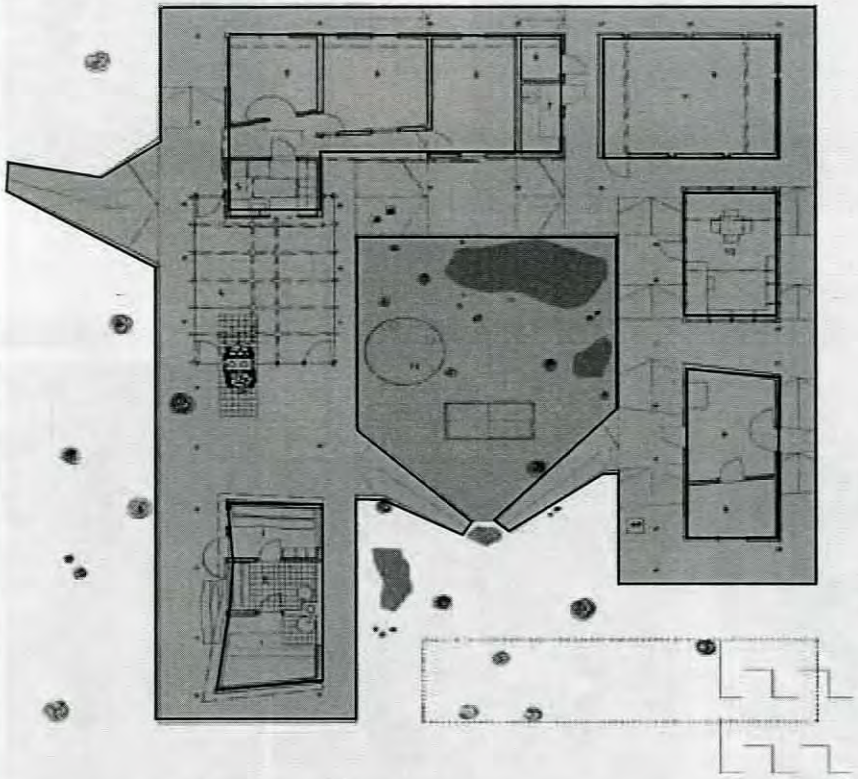


Villa Langbo	Olavi Koponen	Langholmen, Kemio, Finland	1,819	Rural	Summer Home









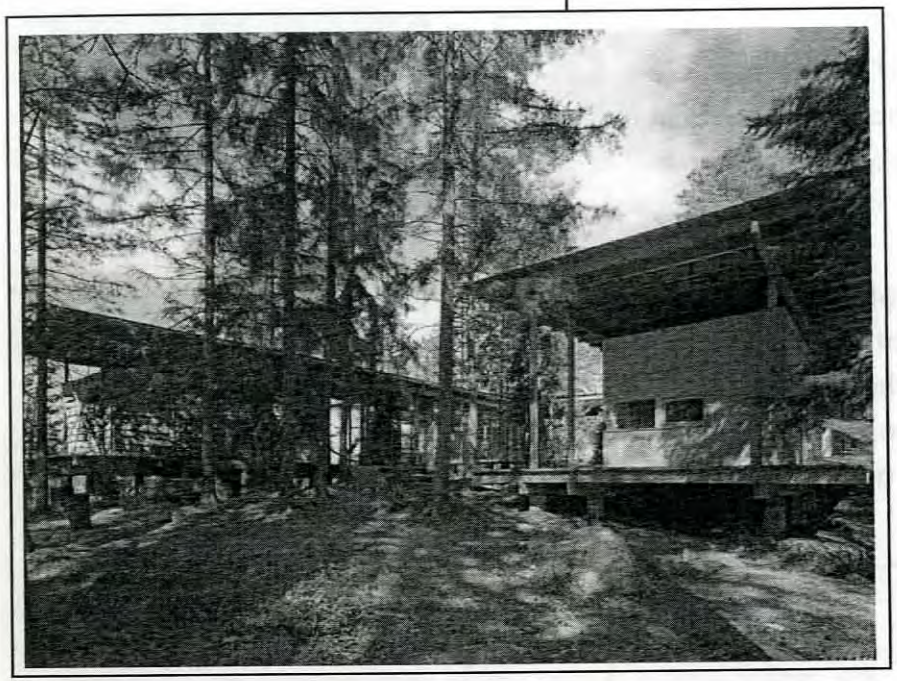
Structure is not inherently understood because it is lacking a repetitive structural system, however clear definition between structural and non structural components helps.

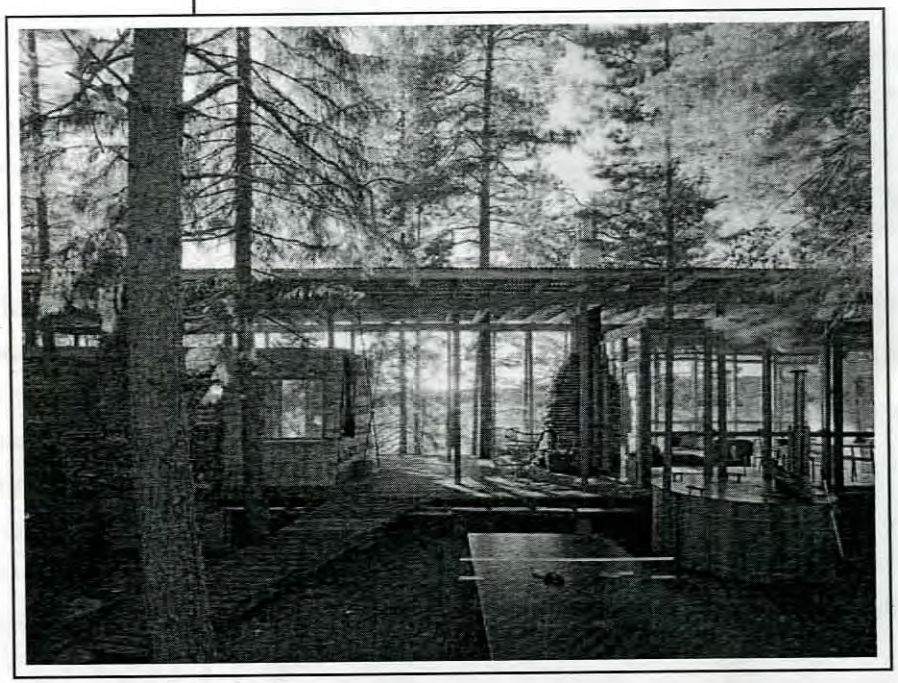
Sits lightly on the land with low impact foundations. Transparent. Using vertical structural members and as little cladding as possible this structure fits into its surroundings and becomes a part of nature

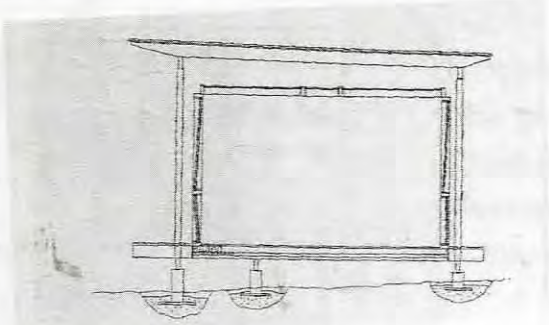
A single building

Encompassing nature

Transparent, separates the layers of container, umbrella and nature

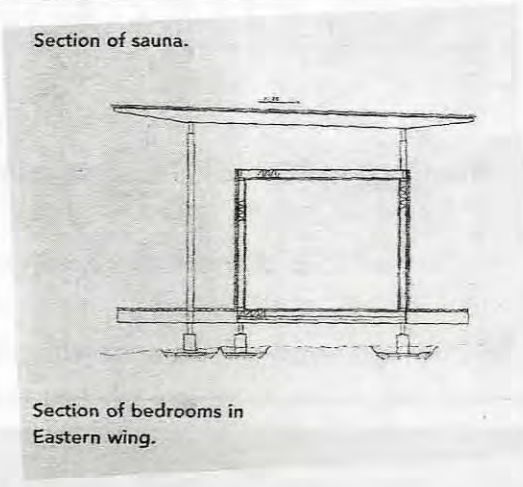




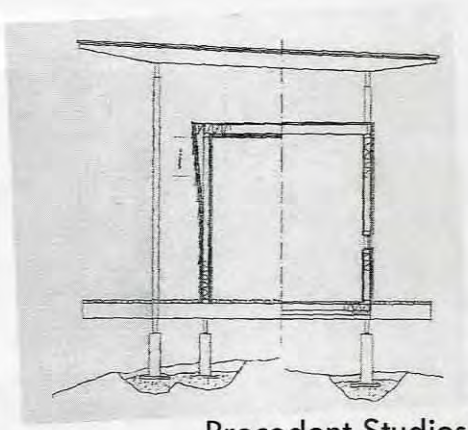


Section of living area.

Section of sauna.

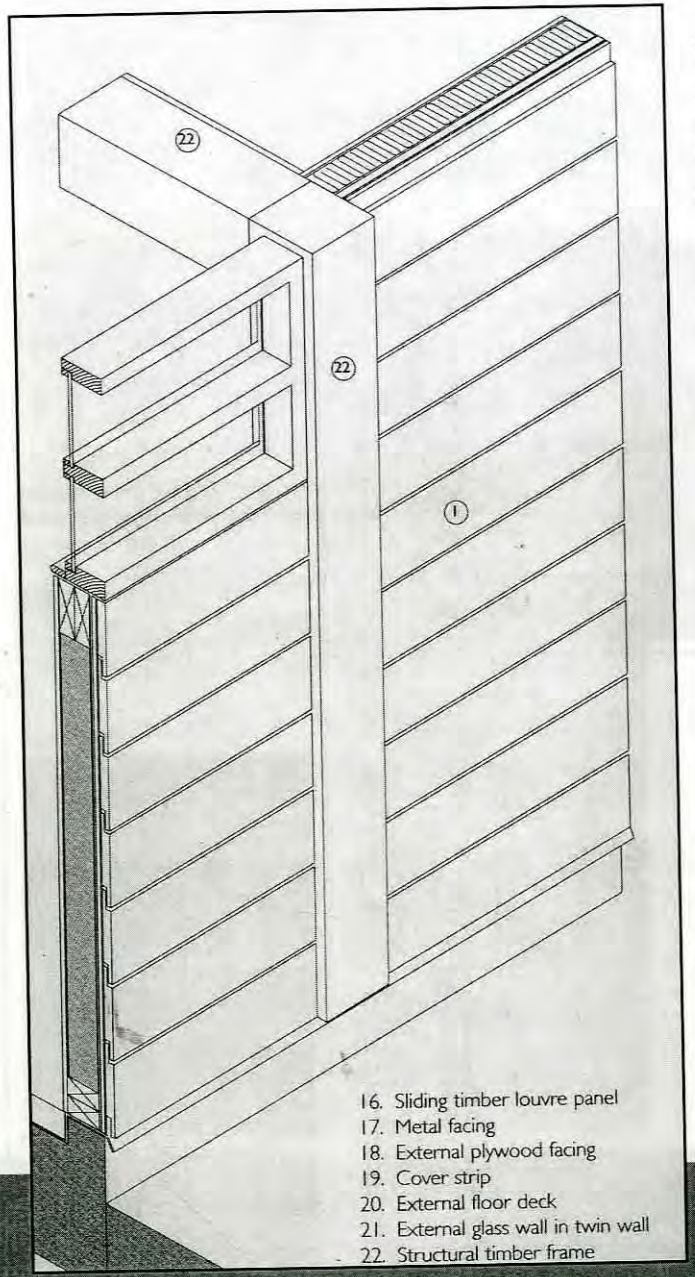


Section of bedrooms in Eastern wing.



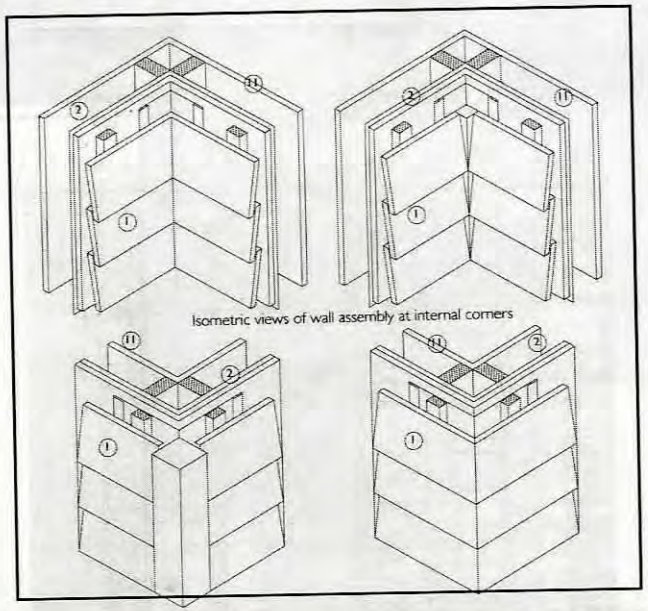
One-Family House Kern Lochau

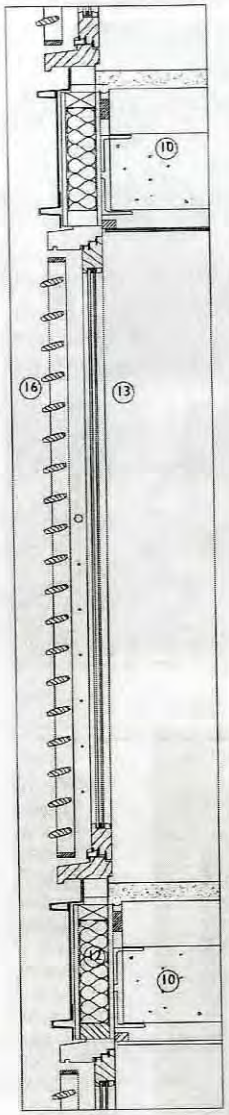
Baumschlager Eberle | Lochau, Vorarlberg, Austria | 1,109 | Suburban | Home

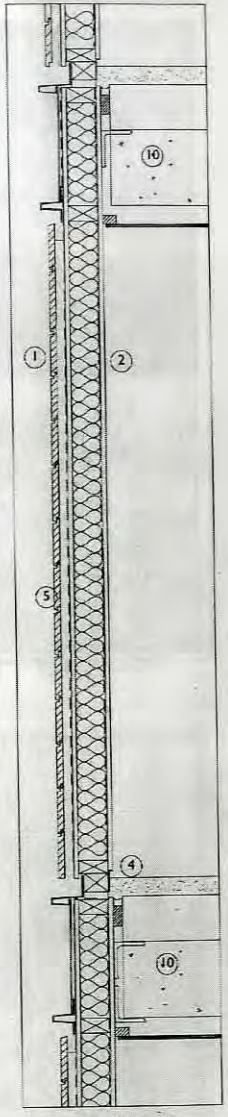


The space is not defined by common elements such as walls, windows or roofs but by a single volume whose consistency is deliberately hidden.

An additional element of junction distributes the upper weight of the cladding system, so as to make the building appear detached from the ground even by a few centimeters and give it extra absence of gravity.



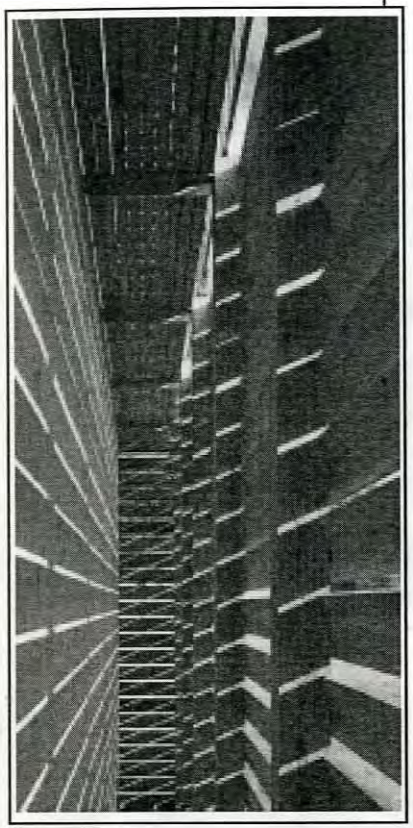


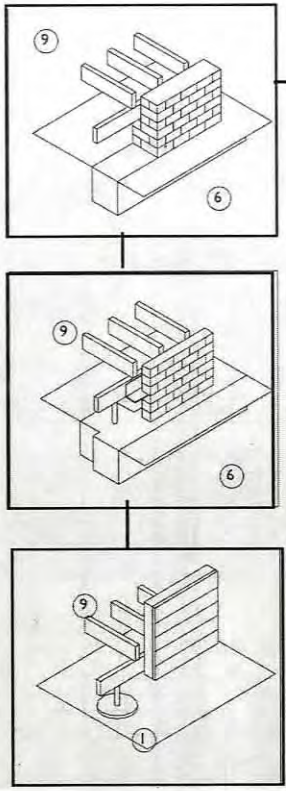


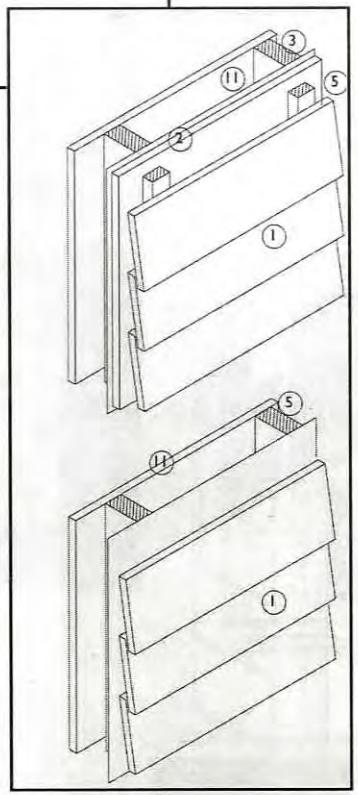
A single building

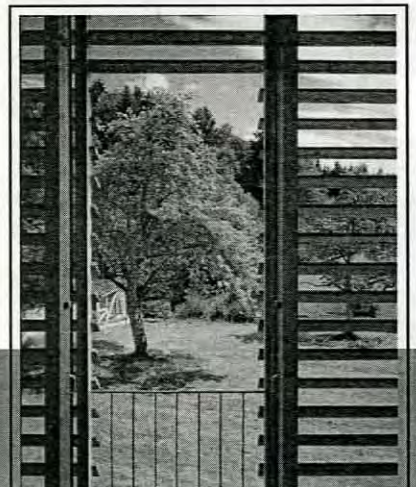
Use of light

Repetitive, articulated



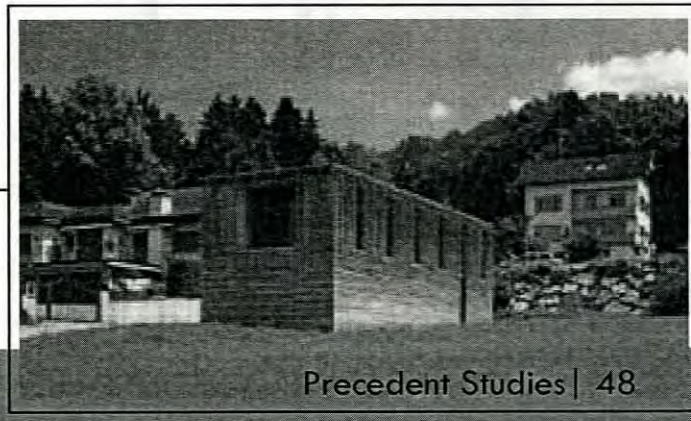






Dimensions

- The glass internal shell is formed by a system of wooden frames, 12 cm in width
- Between the two shells there is a 50 cm cavity for inspection
- 1 meter is the distance of the openings and of the frames that project inside



Strategies Which Reveal

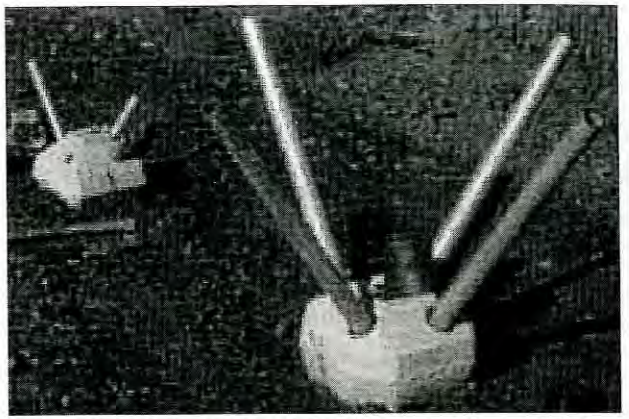
"A post and beam system, combined with exposed connections and minimal partitioning elements will result in an expression that will communicate the visual data about the building's disassembly potential." (Ciarimboli, 21)

Low impact foundation technology (L.I.F.T.)

LIFT systems use steel pipes to anchor foundation walls or piers into the bearing soils. If used with bearing walls, the concrete wall acts like a beam that spans from one collar head to the next, and the two bearing pins at each head collar transfer the load to the bearing soils. When used with piers, the pins are angled in opposing directions to anchor the pier. A buffering material separates the base of the stem wall from the surface soils, so that any potential frost or expansive heave is not transferred to the wall or pier. These systems do not require extensive trenching and facilitate the removal of the concrete wall or piers at building end-of-life. (Ciarimboli, 40)

Reclaimed lumber

As long as it has not been contaminated with toxic preservatives, paints, or adhesives, wood can be reused, recycled, bio-degraded or burned for utilization of its energy content. Solid lumber of sufficient dimension is a highly flexible material for reuse and remanufacturing, as it can be cut and worked to make new sizes and shapes without loss of its base properties. Light wood-framing, while an efficient use of lumber is problematic for disassembly often due to the use of a large number of nails and many small increments of material of relatively small dimension. Clips, angles and plates, bolts, double-headed nails,



Ciarimboli, Nicholas, and Brad Guy. Design for Disassembly in the built environment: a guide to closed-loop design and building. Publication. The Pennsylvania State University. Print.

Reclaimed Lumber. Digital image. Darien Millworks & Timber. Web. 9 Nov. 2009. <http://www.darienmillworks.com>.

are means to make the wood members easier to disassemble. As tools to more rapidly remove nails is developed the labor intensity of disassembly will become less. Building light frame wall panels allows for the potential for the recovery of entire panels for reuse in their entirety as a panel unit, maintaining higher value. Timber framing is typically preferred as it maintains larger sizes of members and typically uses fewer, larger connections. (Ciarimboli, 42)

Screws, bolts and connectors

Screws, bolts and other forms of dry connections allow for ease of disassembly as opposed to friction nails or adhesives. Where nails or bolts are used with connectors, this may allow for fewer nails and therefore less damage to wood members. Various companies have developed specialized connectors for specific applications. For example, one company has developed a line of connectors for decking that allows for connectors accessed from the back side of the materials

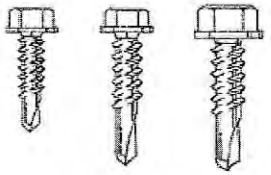


Fig. 68 steel decking screw

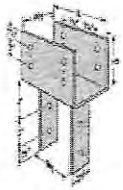


Fig. 69 column cap

Fig. 70 rafter connector

Ciarimboli, Nicholas, and Brad Guy. Design for Disassembly in the built environment: a guide to closed-loop design and building. Publication. The Pennsylvania State University. Print.

Type of Connection	Advantages	Disadvantages
Screw	easily removable	limited reuse of both hole and screws cost
Bolt	strong can be reused a number of times	can seize up, making removal difficult cost
Nail	speed of construction cost	difficult to remove removal usually destroys a key area of element - ends
Friction	keeps construction element whole during removal	relatively undeveloped type of connection structural weakness
Mortar	can be made to variety of strengths	mostly cannot be reused, unless clay strength of mix often over-specified making it difficult to separate bonded layers
Adhesives	strong and efficient deal with awkward joints variety of strengths	virtually impossible to separate bonded layers cannot be easily recycled or reused
Rivet	speed of construction	difficult to remove without destroying a key area of element - ends

and that provides potential to use butt-jointed materials with little to no penetration of the decking materials by any connectors. (Ciarimboli, 43)

Wood siding

Wood as siding can be good material for DfD in particular when used in a vertical application which allows for the replacement of individual boards without impinging upon adjacent boards. Horizontal lapped siding is limited by the layering which laps each piece above the piece below. However, a horizontal pattern means that, while the lower pieces are most susceptible to wear via splash back and in turn rotting, this decay will be limited to the length of fewer pieces rather than the ends of every piece in a vertical application. Painting wood siding greatly limits its reuse and recycling potential while increasing its life. This is a tradeoff that can be somewhat avoided by design which allows for deep overhangs and rain-screens or other drying wall designs that prevent the accumulation of moisture. (Ciarimboli, 44)

Timber Cladding. Digital image. Proper Wood Sheds. Web. 1 Nov. 2009.

Rigid insulation

Rigid foam insulation such as polyisocyanurate (polyiso), expanded polystyrene (EPS) and extruded polystyrene (XPS), popularly known under its trademark name Styrofoam, are cut into panels and fitted into walls, floors and ceilings. They are also used externally on decking, under roofing or over wall sheathing under the exterior siding. When removing the panels in a disassembly process their self-supporting form will allow them to be removed intact for reuse. These materials are also recyclable and can be made from recycled-content. A major distinction is that EPS uses pentane as a blowing agent whereas polyisocyanurate and XPS use variants of ozone depleting chemicals. (Ciarimboli, 45)

EPS. Digital image. Web. 9 Nov. 2009. <www.finehomebuilding.com>.

Wood Qualities and Techniques

Wood is flexible. There are many variations of what and how to build while using wood. Here are examples of log corner connections, ways to divide a tree into planks and a table explaining the use of various species of wood and their qualities.

A tree is not uniform. It has vertical striations of strength and flexibility. This must be understood when cutting a tree into planks because if it is not, only half of the wood will be usable. It is also crucial to understand the properties of the type of wood one is using. Each type of wood is unique and will produce a different result. Lastly it is important to keep in mind the lifespan of material use. Not all wood is created equal in this sense. Depending on the weather condition and maintenance each species of wood has a different durability.

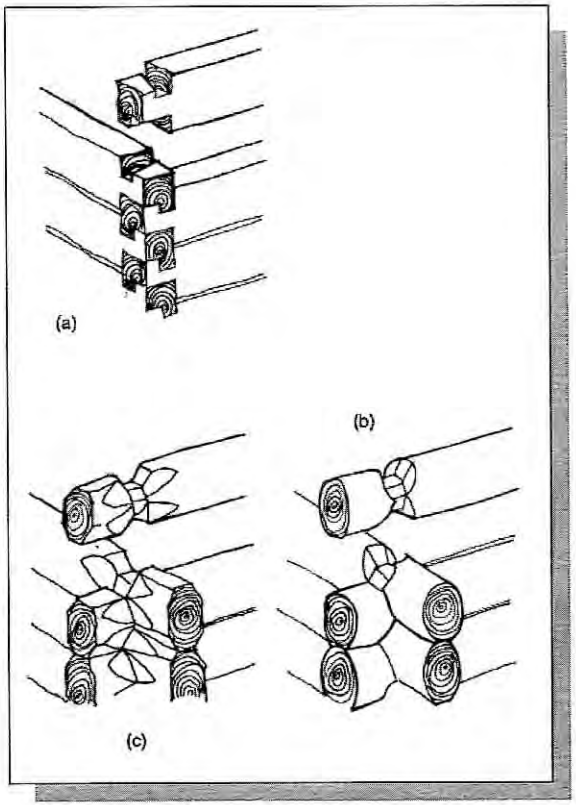


Figure 13.38: Some log joints.

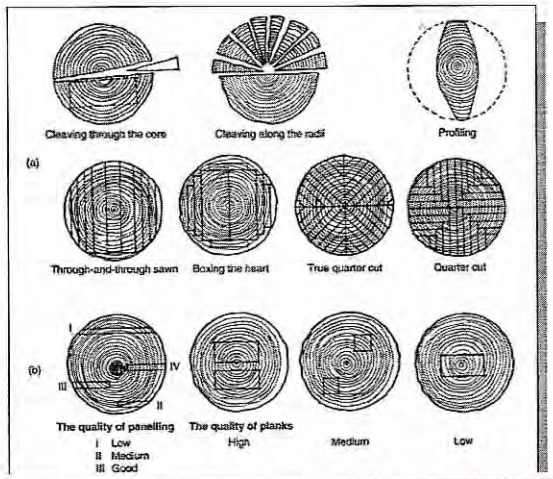


Table 10.6: Use of timber in building

Timber	*Properties*[1]	*Areas of use*
Scots pine (*Pinus sylvestris*)	Soft, elastic, strong, durable, easy to cleave and work, denser and more resin than in spruce, difficult to glue and paint, can be pressure impregnated	Structures, floors, cladding, windows, doors, tar, roofing, foundations below ground level, plugs
Norway spruce (*Picea abies*)	Soft, elastic and medium hard wearing, sensitive to moisture, easy to glue and paint, difficult to pressure impregnate	Structures, roofing, cladding, laminated timber, fibreboard
European larch (*Larix decidua*)	Tough, strong and durable, good moisture resistance, easy to work, cannot be painted	Structures, floor plate, doors, windows, roofing
Common juniper (*Juniperus communis*)	Tough, firm and very durable, difficult to split but easy to work	Cladding plugs
English oak (*Quercus robur*)	Dense, heavy, hard, hard wearing, elastic and durable, tendency to twist, quite difficult to work moisture resistant	Structures, floors, windows, doors, thresholds, plugs, cladding, roofing
Aspen (*Populus tremula*)	Moisture resistant but strongest when dry, does not twist	Floors, plywood, suspended ceiling, smaller structures, cladding, piping for water and gutters, piles
White birch (*Betula pubescens*)	Tough, strong, elastic, low resistance to moisture, twists easily, easy to work	Floors, stairs, internal panelling, veneer, chipboard, bark for damp proofing, smaller structures
Silver birch (*Betula pendula*)		
Norway maple (*Acer platanoides*)	Hard, dense, tough, elastic, flexible, hard wearing, low resistance to moisture, easy to work	Floors, balustrades, stairs, plugs
Common ash (*Fraxinus excelsior*)	Hard, dense, tough, elastic, low resistance to moisture, easy to bend under steam	Floors, veneer, internal panelling, stairs, internal structural details
Common beech (*Fagus sylvatica*)	Hard, strong, medium resistance to moisture, twists easily, no smell, easy to work	Floors, balustrades, smaller structures, veneer, internal panelling, tar, vinegar
Wych elm (*Ulmus glabra*)	Strong, tough, elastic, durable, moisture resistant, not particularly easy to work	Floors, balustrades, piles, stairs, panelling, internal structural details
Lime (*Tilia cordata*)	Tough, medium strong, slightly elastic, easy to work	Smaller structures (used for log buildings in the Carpathians), internal panelling, veneer, fibre for woven wallpaper and rope
Common alder (*Alnus glutinosa*)	Not particularly durable in air, very durable under water, soft, light, brittle, twists easily, easy to work	Piles, gutters, veneer, internal cladding

Table 10.6: Use of timber in building – *continued*

Timber	*Properties*[1]	*Areas of use*
Common hazel (*Corylus avellana*)	Strong and elastic, not particularly durable	Wattle walling in timber framework
Grey alder (*Alnus incana*)	Not particularly durable, light and brittle, easy to work	Internal panelling, veneer
Wild cherry (*Prunnus avium*)	Stable, hard wearing	Floors
Plum (*Prunus domestica*)	Splits easily when dried	Veneer
Holly (*Helix aquifolium*)	Hard, homogeneous, hard wearing	Veneer
Apple (*Malus pumile*)	Hard, homogeneous, hard wearing, low resistance to moisture	Wooden screws, dowels, thresholds
White willow (*Salix alloa*)	Tough, elastic, easy to cleave	Veneer, wattle cladding on external walls
Rowan or mountain ash (*Sorbus aucuparia*)	Heavy, hard, tough, durable, hard wearing, easy to work	Wattle cladding on external walls

Note:
(1) Varies according to place of origin and the conditions of growth

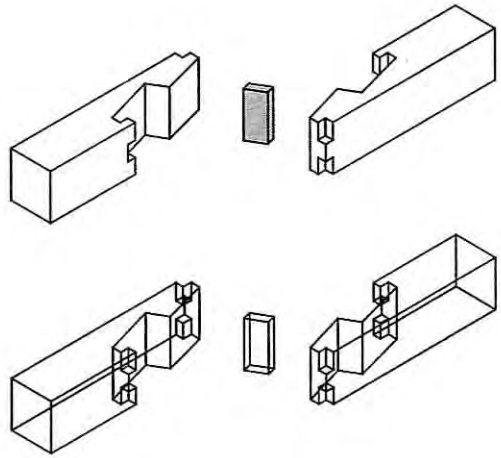
Table 10.7: Durability of timber in years in different situations

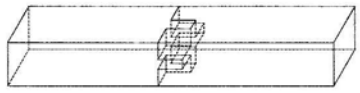
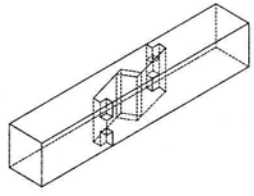
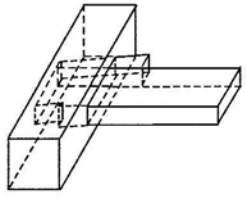
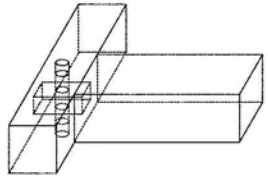
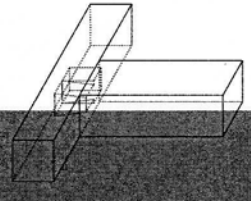
Timber	*Always dry*	*Sheltered outside*	*Unsheltered outside*	*In contact with earth*	*Underwater*
Pine	120–1000	90–120	40–85	7–8	500
Spruce	120–900	50–75	40–70	3–4	50–100
Larch	1800	90–150	40–90	9–10	More than 1500
Juniper	–	More than 100	100	–	–
Oak	300–800	100–200	50–120	15–20	More than 500
Aspen	–	Low	–	Low	High
Birch	500	3–40	3–40	Less than 5	20
Maple	–	–	–	Less than 5	Less than 20
Ash	300–800	30–100	15–60	Less than 5	Less than 20
Beech	300–800	5–100	10–60	5	More than 300
Elm	1500	80–180	6–100	5–10	More than 500
Silver fir	900	50	50	–	–
Willow	600	5–40	5–30	–	–
Poplar	500	3–40	3–40	Less than 5	–

Joint Analysis

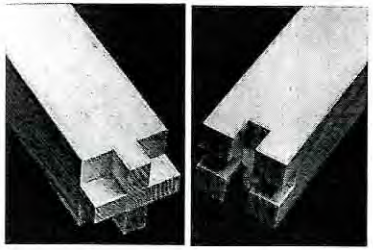
"Detail is the adoration of nature" – Louis Kahn

By studying joints one can begin to understand the process of connection in architecture. The typical idea is that either adhesive, nail, or mortar will connect part a with part b, but this misconception does not allow for the understanding of the relationship of forces. Japanese joints in particular articulate their ability to resist strain and connect items. The Amish use a typical mortise and tennon joint, where the columns and beams are made out of green wood that will shrink, while the pins are made out of dry, hard wood- producing a joint that may never come apart. This type of joint while strong does not meet the needs of flexibility and alteration that the ever growing world needs. An effective joint is one that exposes its properties but is able to be taken apart and reassembled.

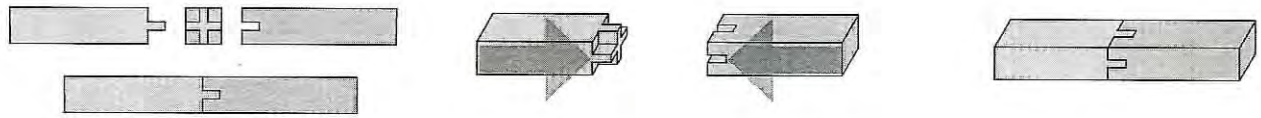


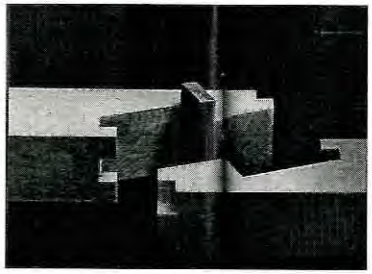
Joint		Type	Forces Resisted	Best For
Cross Shaped Tenon and Mortise Splice Mechiire or Juji-mechigai-tsugi		Splicing	Resists Torsion Not Tensile Forces	Not very structural- used for decorative beams or lintels.
Mortised Rabbeted Oblique Scarf Joint Kamawa-tsigi		Splicing	Resists Torsion and Bending Stress Not Tensile Forces	Used for underpinnings of pillars Structural
Wedged Through Half Dovetail Joint Sage-kama or katasage ari		Connecting	Resists Torsion	Used when rails must pass through posts
Mortise and Tennon Joint Komi-sen, draw pin joint		Connecting	Resists Tensile Forces	Long term construction -green wood vs. dry, hard wood produces strong joint
Housed Dovetail Joint Ari-otoshi or Okuri ari		Connecting	Poor under great forces	Better fit for temporary framing or cabinets

Source of Images: Seike, Kiyosi. The Art of Japanese Joinery. New York: Weatherhill, 1977. Print

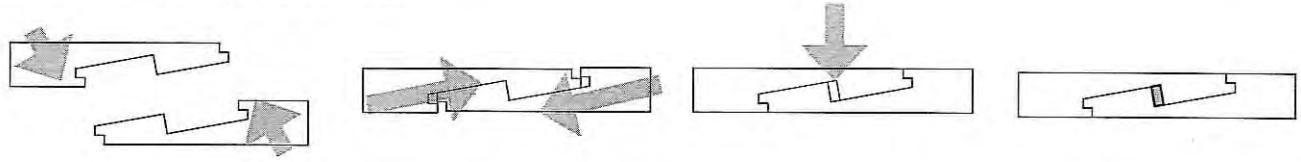


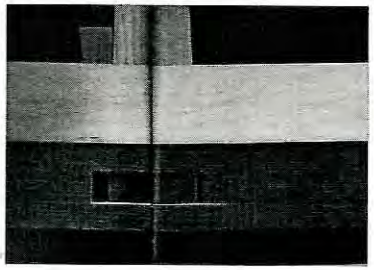
Cross Shaped Tenon and Mortise Splice



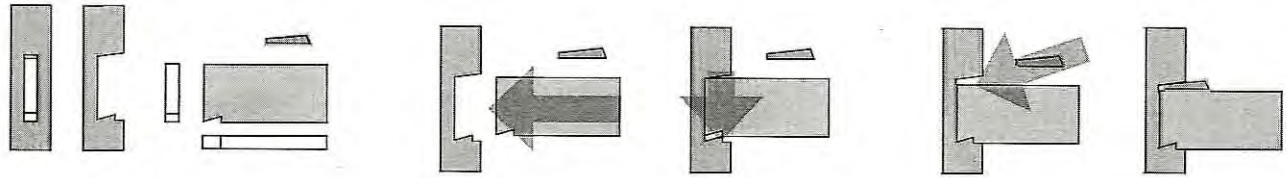


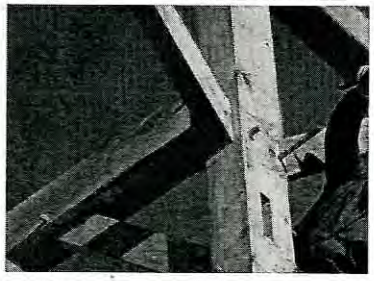
Mortised Rabbeted Oblique Scarf Joint



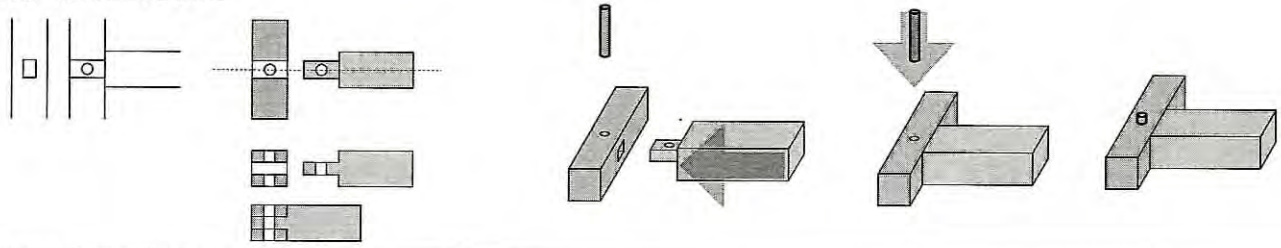


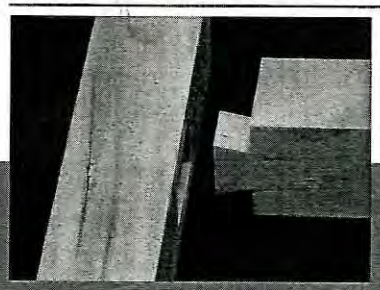
Wedged Through Half Dovetail Joint



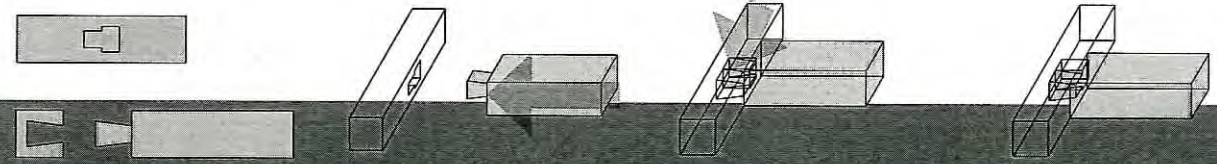


Mortise and Tennon Joint





Housed Dovetail Joint



Environmental Education Center

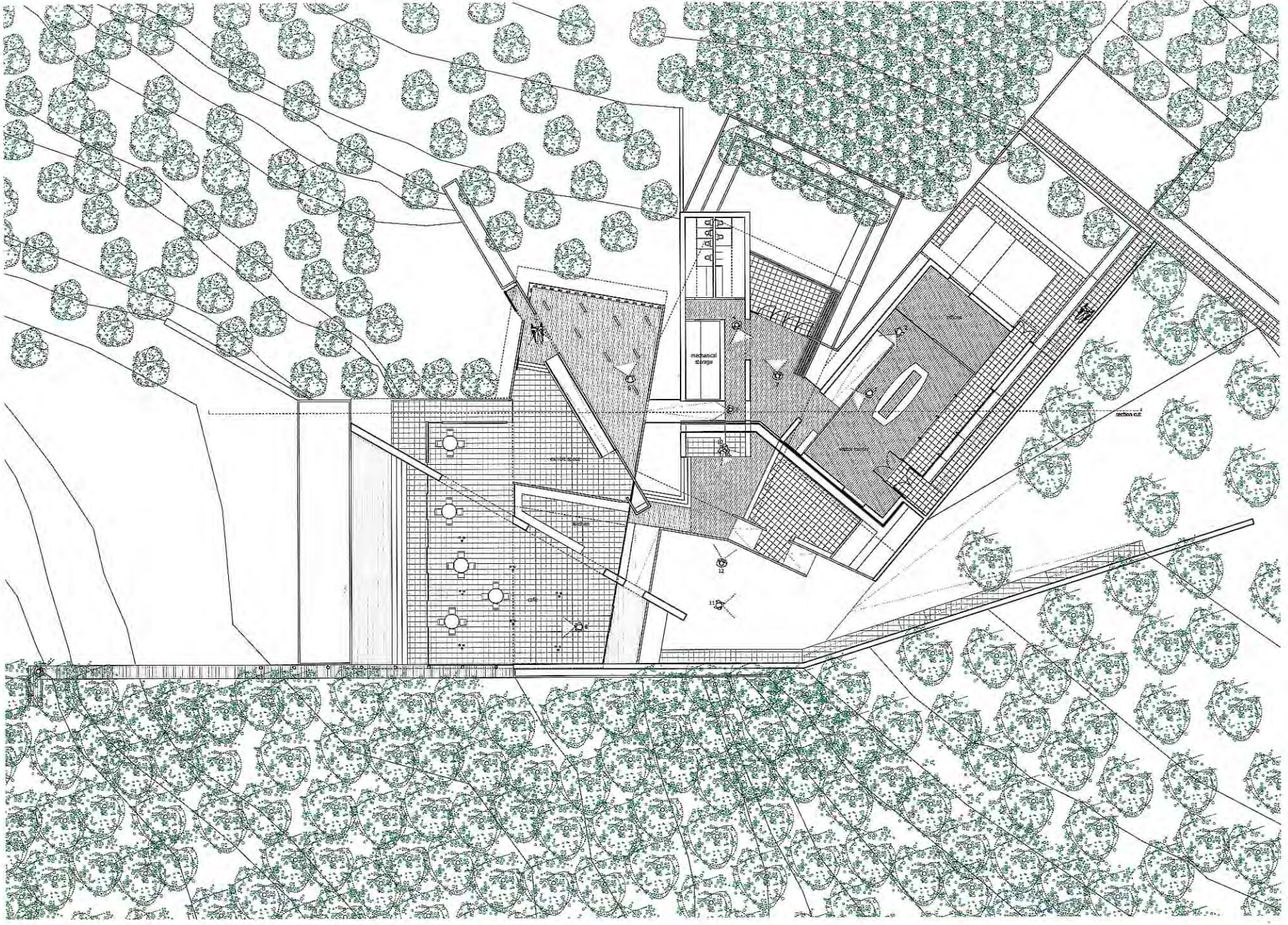
Kingfield, ME

Designed to educate the influx of urban tourists in a rural location, this Environmental Education Center is teaching people of lumber production and the use of the local materials.

It is located in the western mountains of Maine, overlooking the valley below. By juxtaposing and exaggerating the process of wood's production the building is understood as a series of stages. Each stage is delaminating the typical understanding of the separation between the built environment and the natural one. Starting with the typical building organization of inside verses outside and ending with the forest.

Using the tectonic nature of architecture as the vehicle, the architecture educates its users of material life cycles. Through revealing these stages of production the physical process of a buildings formation can be understood, along with architecture inherent connection to nature.

Formally the building is comprised of a series of progressively larger and longer walls. These walls are juxtaposed against the consistently rotating roof. This roof gets successively steeper and opens out on the unfiltered view the neighboring mountain range and natures uncontrollable expanse.


mechanical storage
section cut


1


2


3


4

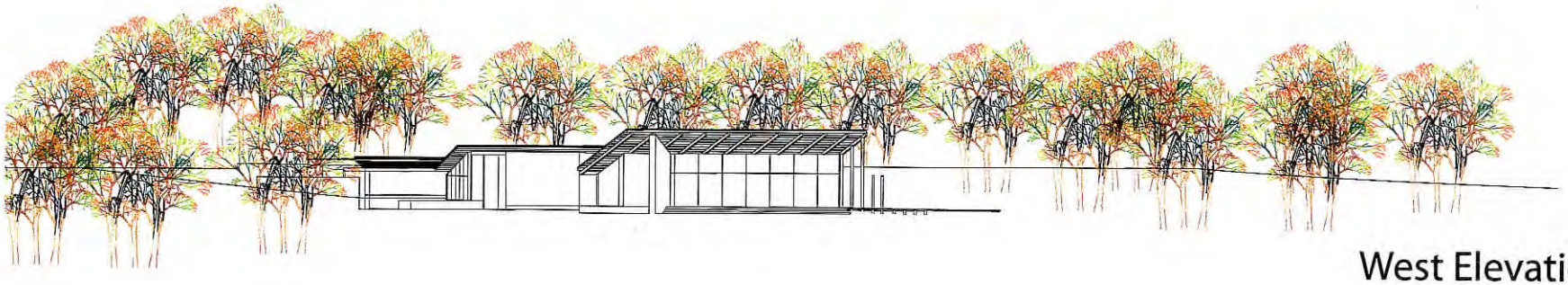

7


8

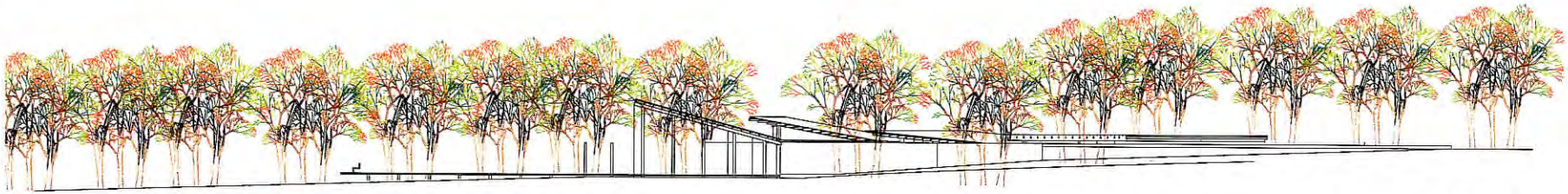

9


10


12

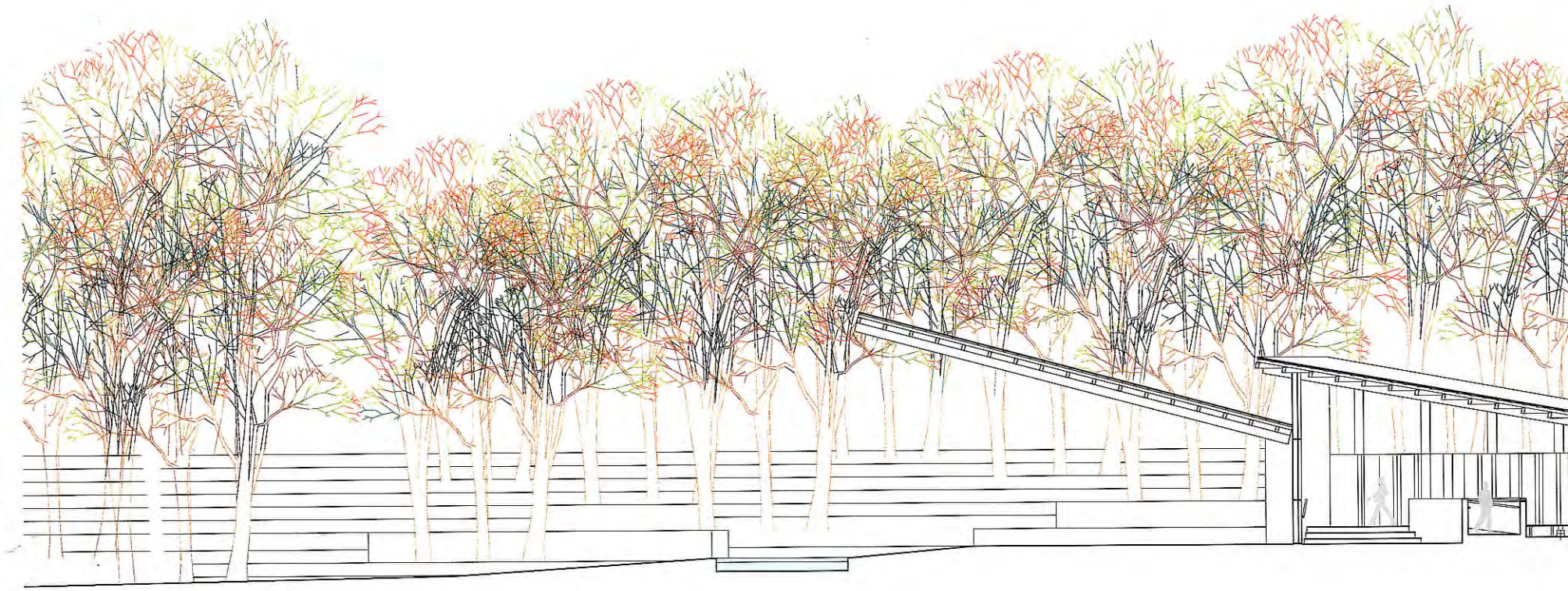


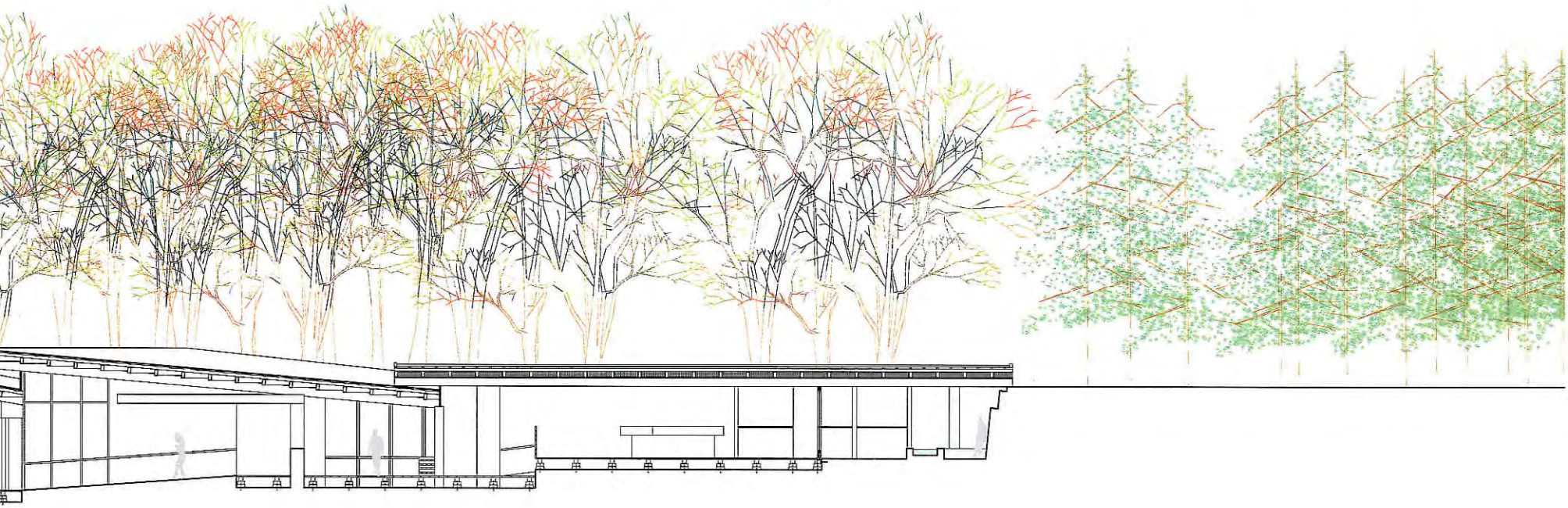
West Elevation

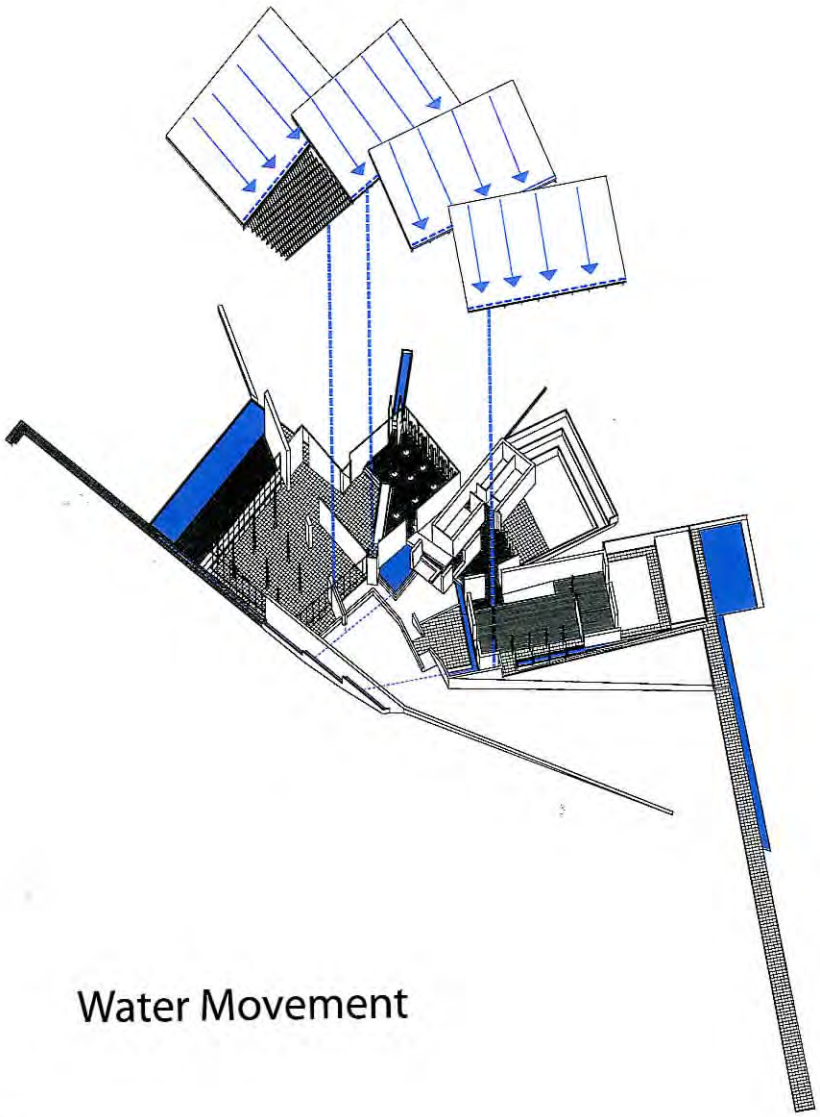


South Elevation

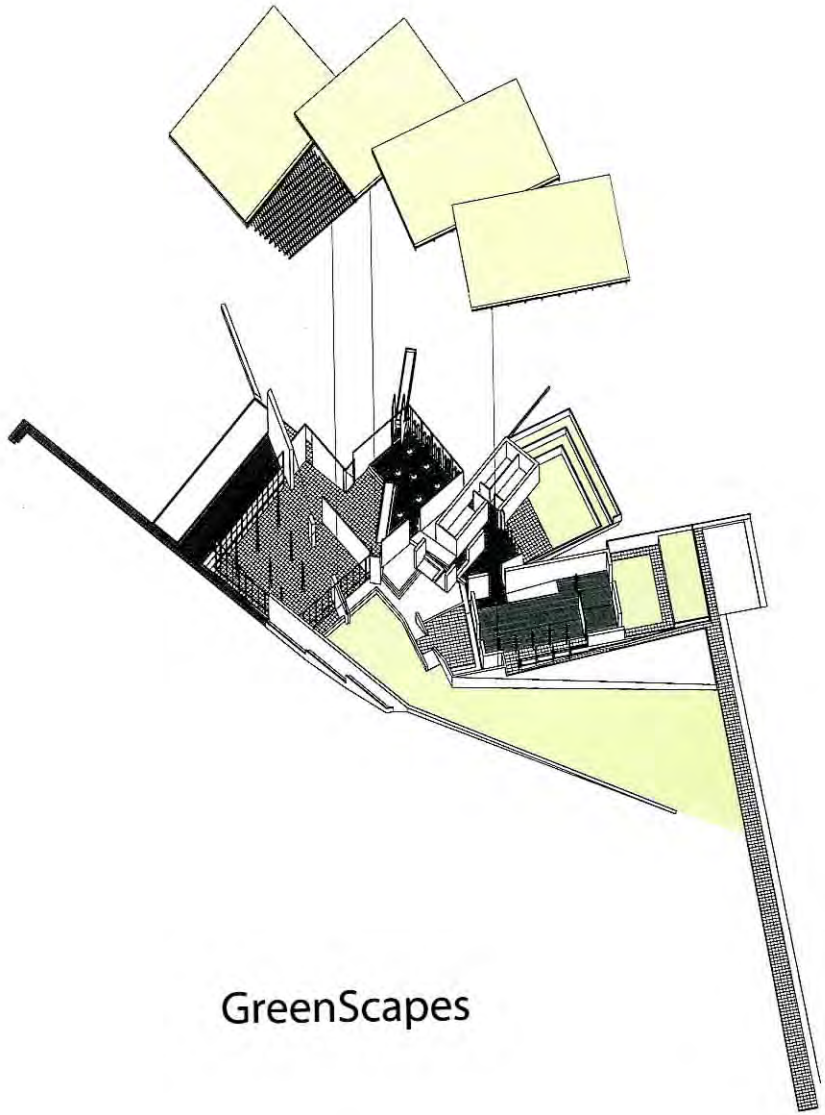
North-West Elevation



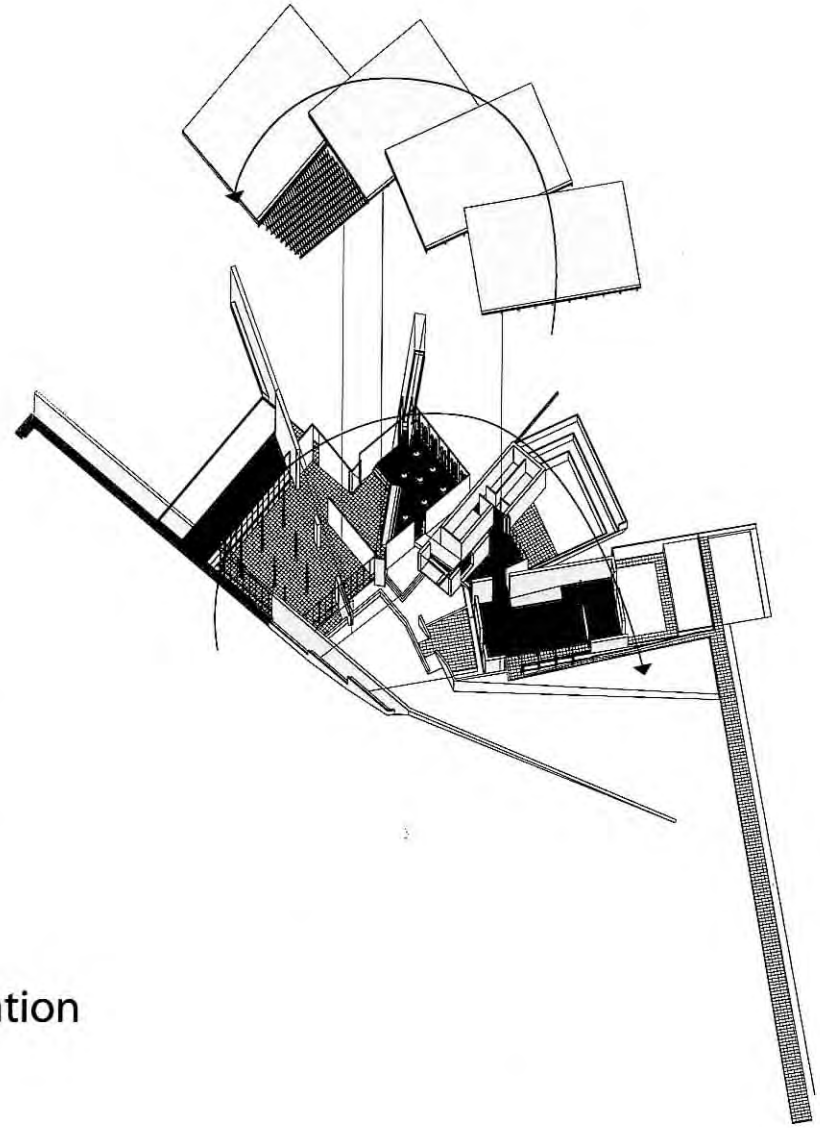




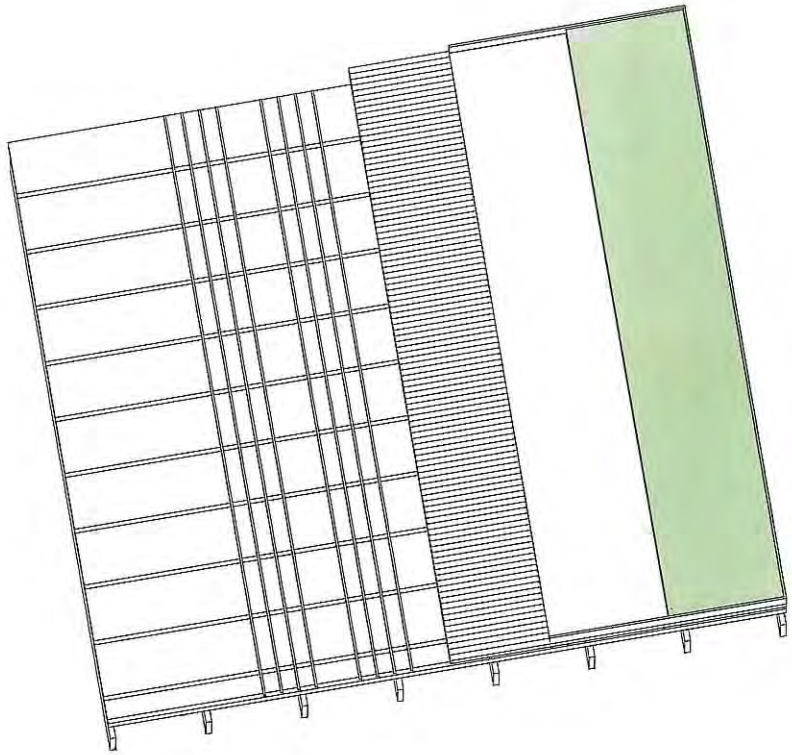
Water Movement



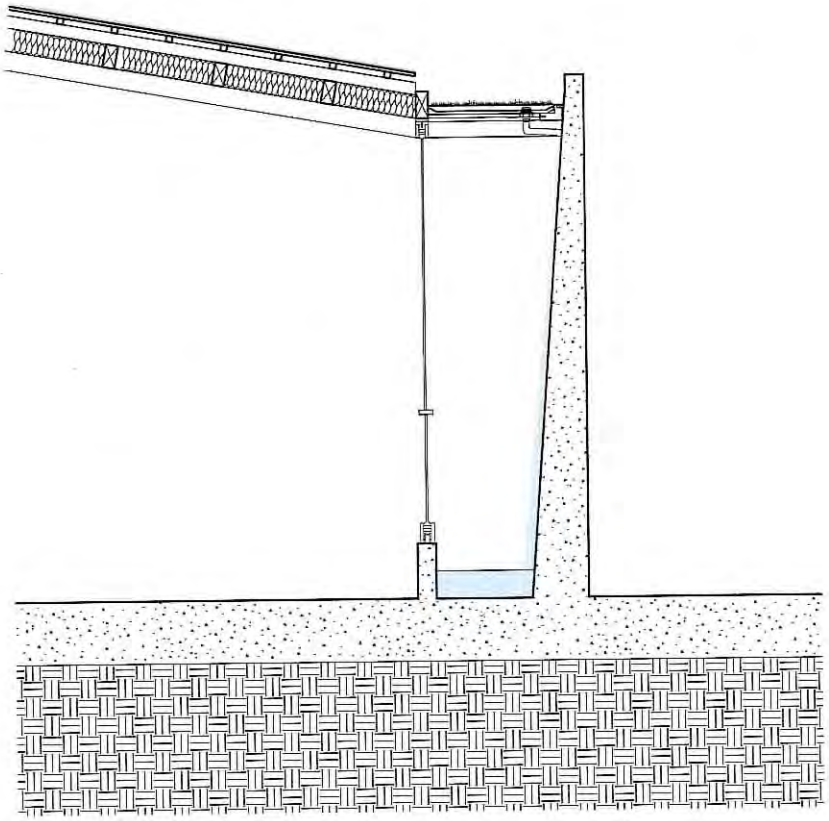
GreenScapes



Rotation



Roof Structure



Water Wall

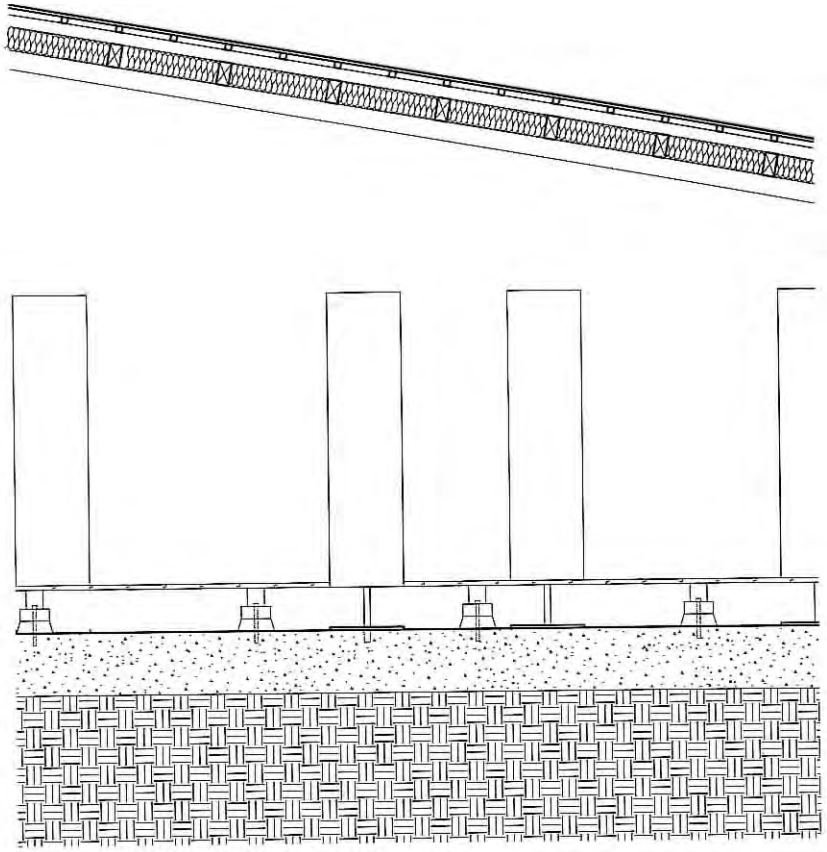
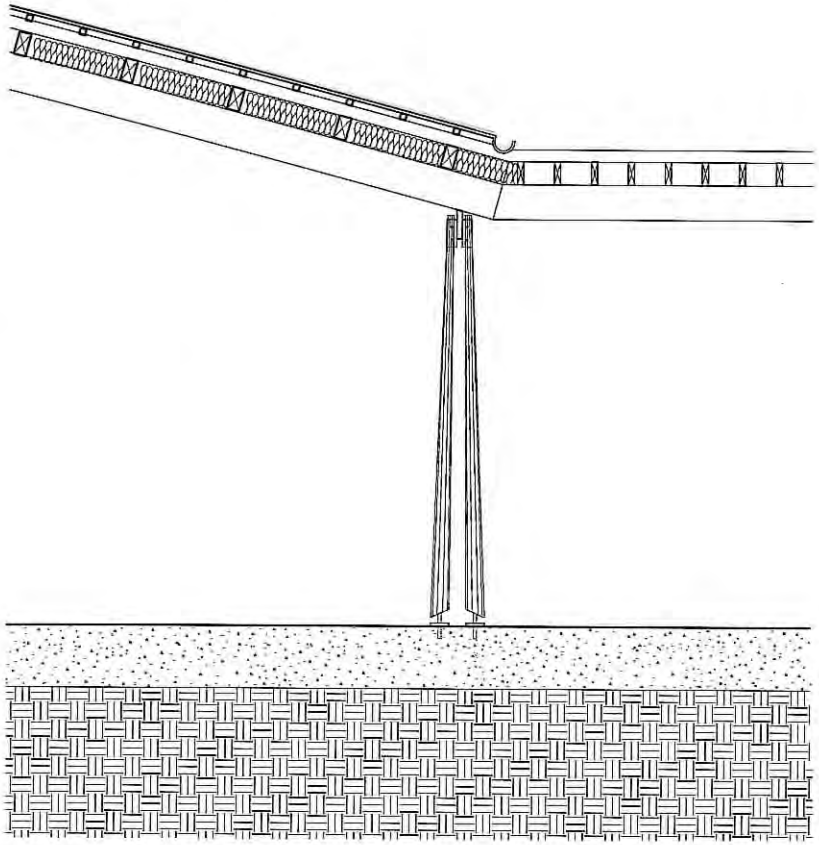
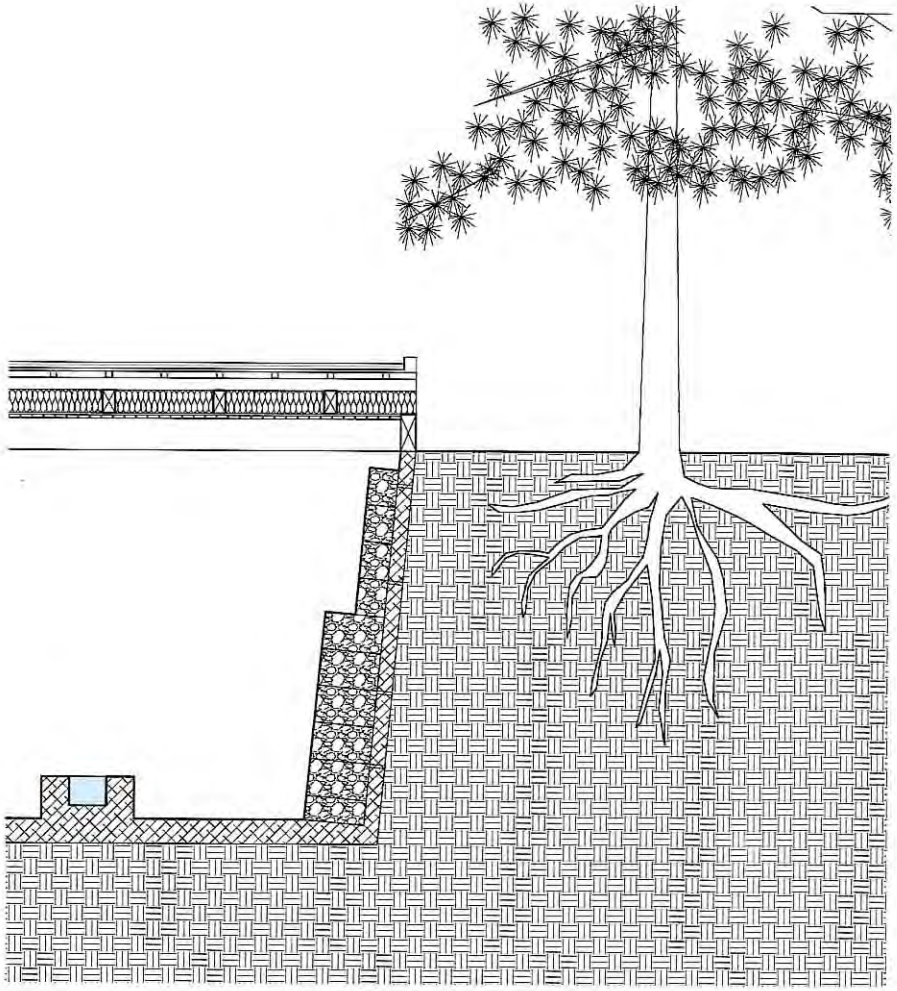


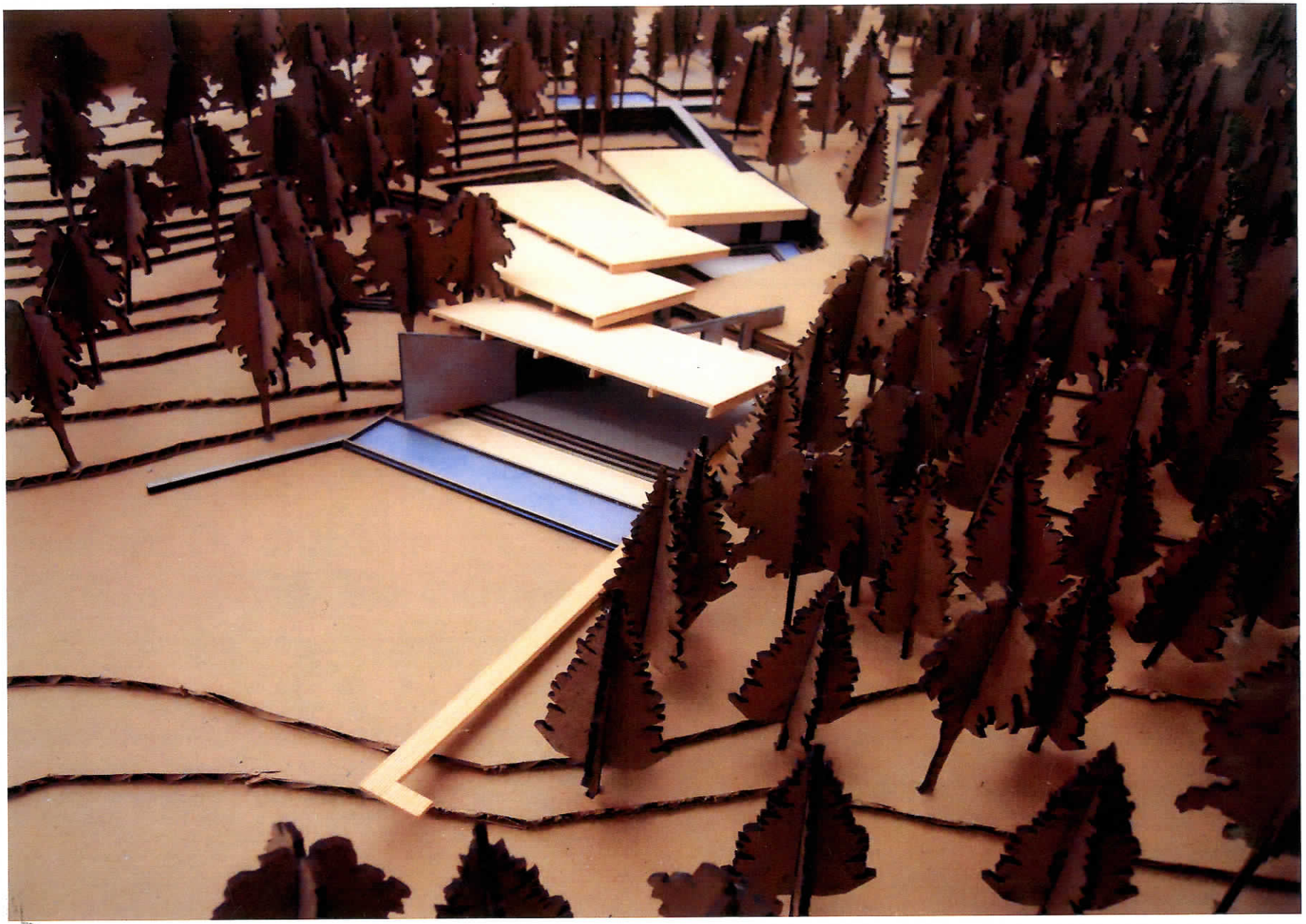
Exhibit Space



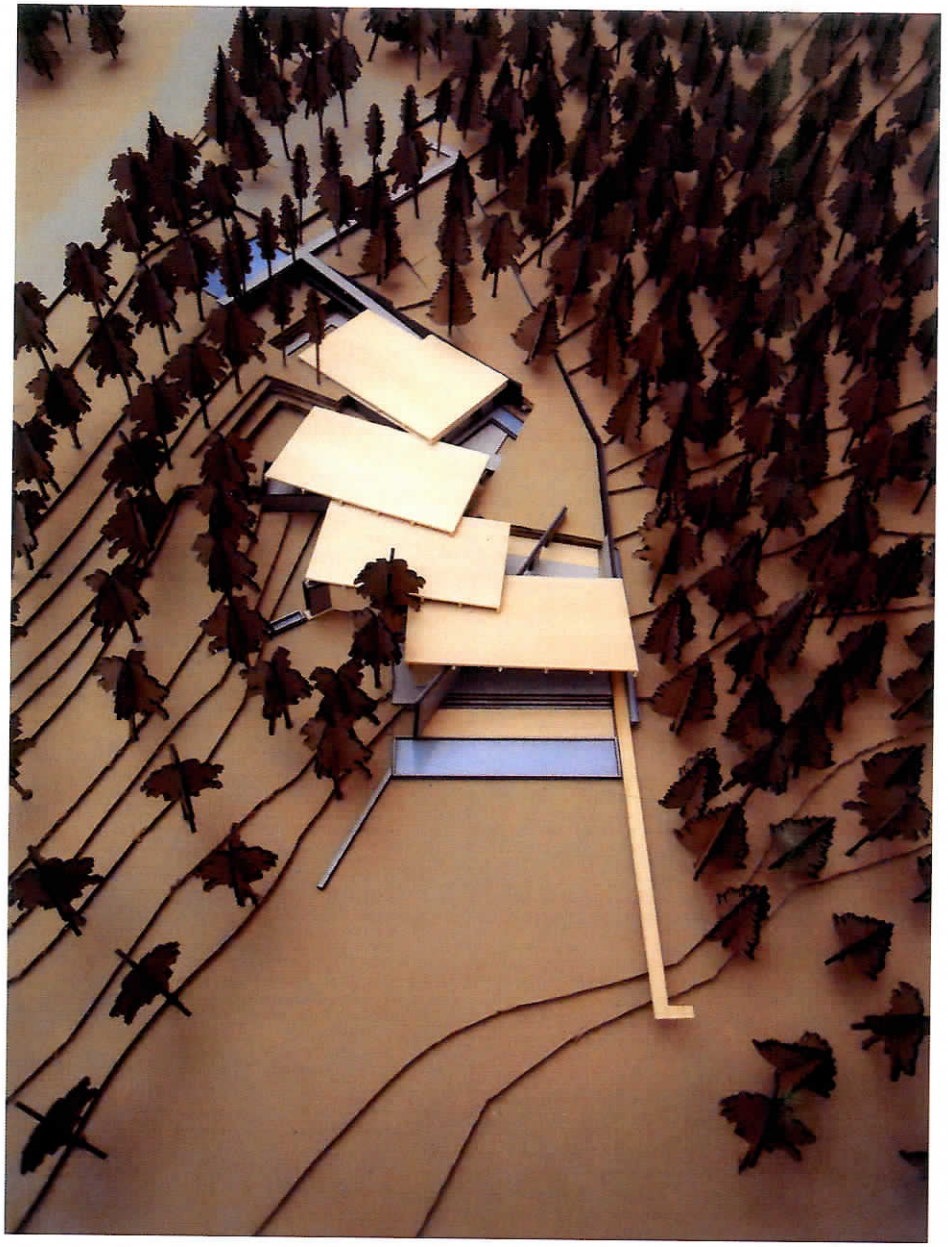
Column Detail



Retaining Wall



Site Model



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Looks at the densification and urbanization of humans; with useful facts about the increase of the world urban population from 224 million in 1900 to 2.9 billion in 1999. Importantly Alberti acknowledges that humans differ from ecosystems and begins to look at their patterns of use and effect, focusing on urban sprawl.

Allen, Edward,. Fundamentals of building construction materials and methods. Hoboken, N.J: J. Wiley & Sons, 2004. Print.

A great source that combines information about the entirty of wood construction and techniques. Beginning with tree growth and ending with interior wooden finishes. Contained great diagrams as well as information about woods role in a sustainable world.

Baker-Laporte, Paula, and Robert Laporte. Eco Nest Creating Sustiable Sanctuaries of Clay, Straw, and TImber. Layton: Gibbs Smith, 2005. Print.

This source speaks to a specific building technique that bases itself off of being eco friendly to the point where the home will decompose on it's own, just as a birds nest found in the natural ecosystem.

"Business & Industry." Census Bureau Home Page. Web. 05 Oct. 2009. <http://www.census.gov/econ/index.html>.

Information on construction techniques, price per square foot, number of rooms and number of stories in construction by area within the United States.

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DfD is a strong supporting movement to my thesis which deals with the disassembly of a structure and the ways to be successful in designing for it.

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This website is researching and educating about the sustainability of using wood as the most renewable resource for construction. It led me to finding an array of other resources on the same topic.

Crowther, Philip. "7. Design of Buildings and Components for Deconstruction." Deconstruction: Techniques, Economics, and Safety. Australia: Queensland University of Technology. Print.

Contains ideas of rethinking material lifespans and has many flow charts and tables which provide pertinent information.

Dean, Andrea Oppenheimer. Proceed and be bold Rural Studio after Samuel Mockbee. New York: Princeton Architectural, 2005. Print.

This book tells the story of the Rural Studio in Hale County, Alabama and how they transform the ordinary into extraordinary, literally. A great resource for various uses of unexpected materials and their application in areas of rural poverty. It also addresses community involvement and devel-

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Fisher, Thomas. Architectural Design and Ethics. Oxford: Architectural, 2008. Print.
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Nesbitt, Kate. Theorizing a New Agenda for Architecture An Anthology of Architectural Theory 1965-1995. New York: Princeton Architectural, 1997. Print.
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Paredes, Cristina. Homes on Distinctive Land. Minneapolis: Loft Publications, 2007. Print.
This book gives me a look at both the good and bad ways of handling a naturally unique site. Some of the houses focus on the inside out; the views of the landscape and framing a picture. Others are interesting for the way they touch the land. How the earth is carved out and a building emerges.

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